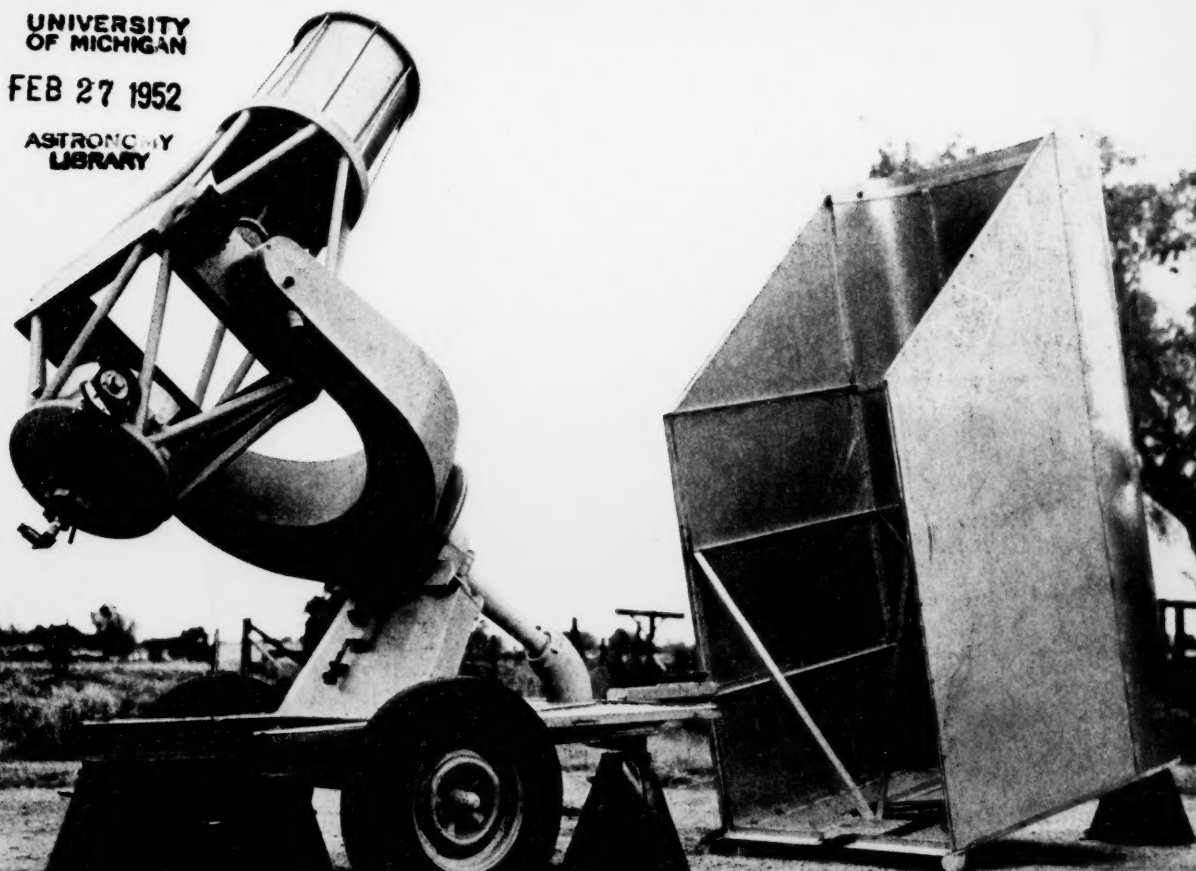


# Sky and TELESCOPE

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MARCH 1952

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## ANTONIA C. MAURY

**A**LMOST legendary seems the career of a woman astronomer and naturalist who died at Hastings-on-Hudson, N. Y., on January 8th in her 86th year. A niece of Henry Draper and granddaughter of Dr. John William Draper (the American pioneer in the application of photography to astronomy), Miss Antonia C. de P. P. Maury was a research associate at the Harvard Observatory from 1888 to 1935. Her great-grandfather had been the British physician to Dom Pedro I, emperor of Brazil, and had married the descendent of a noted Portuguese family, the de Piva Pereiras. Her own father was a minister who was also a naturalist and editor of a geographical magazine. Thus Miss Maury's scientific and cultural heritage was rich and varied. While astronomy became her chief profession, she was also a recognized ornithologist and naturalist.

At Harvard, her first interests were concerned with spectra, partly in deference to the pioneering work of her illustrious uncle and the establishment of the Henry Draper memorial at Harvard. Her early investigations of stellar spectra (1888-1896) enabled Ejnar Hertzsprung in 1905 to confirm his discovery of giants and dwarfs among the stars of the same temperature-spectral class.

When E. C. Pickering at Harvard discovered the first spectroscopic binary, Mizar, in 1889, Miss Maury was the



An undated picture of Garrett P. Serviss and Miss Maury, taken by William Henry.

# Sky and TELESCOPE

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first to determine its period, 104 days. She, herself, discovered the second such star, Beta Aurigae, with a period of only about four days. Spectroscopic binaries thereafter became her chief astronomical interest. She spent many years investigating the puzzling and very complex spectrum of Beta Lyrae, on which she published minute details in the Harvard *Annals* in 1933. And until 1948 she paid nearly annual visits to Harvard expressly to examine current photographs of the spectrum of Beta Lyrae in order to test her own predictions on its behavior. The spectra she used were taken with the 11-inch Draper refractor, an instrument originally belonging to Henry Draper but donated to Harvard by his widow. The program for Miss Maury was nearly the last scientific use to which the famous old telescope was put before it was sent to China (*Sky and Telescope*, November, 1947).

Upon her retirement from Harvard Miss Maury was for several years

curator of the Draper Park Museum at Hastings-on-Hudson. The museum was the old Draper Observatory, built in 1860 and containing many mementos of the astronomical activities of both John William and Henry Draper. Of particular interest was the mounting of Henry's large reflector. It was in a dome that had been added to the original structure in 1869, and this part of the building was rapidly deteriorating. But the telescope mounting, made of South American hardwood, still looked almost new in 1938. As a staunch conservationist (in regard to antiquities and natural resources) Miss Maury regretted greatly that this wing of the observatory eventually had to be torn down, as being beyond repair. The museum and Draper Park (part of the original Draper estates) overlooking the beautiful Hudson River remain as a public memorial not only to the Drapers but to John William Draper's granddaughter, Antonia C. Maury.

DORRIT HOFFLEIT

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WHOLE NUMBER 125

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**COVER:** A 16-inch reflecting telescope built by William A. Rhodes, Phoenix, Ariz., f/3.3 Newtonian and f/18 Gregorian. Telescope and mounting weigh 2,200 pounds, but can be covered and transported on the wheels and axle. Panoramic Research photo. (See page 122.)

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**BACK COVER:** The region of the bowl of the Big Dipper, centered at about  $11^{\text{h}} 30^{\text{m}}, +58^{\circ}$ , enlarged from a 136-minute exposure with a 3-inch Ross-Fecker patrol camera at Harvard Observatory's Agassiz (Oak Ridge) station in Massachusetts. For the positions of more than two dozen galaxies in this region, some of which may be detected in the photograph, see the list in Deep-Sky Wonders, page 129. North is at the left. Harvard Observatory photo.

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# A Domesticated Eclipsing Binary System

BY WILLIAM A. CALDER, *Bradley Observatory, Agnes Scott College*

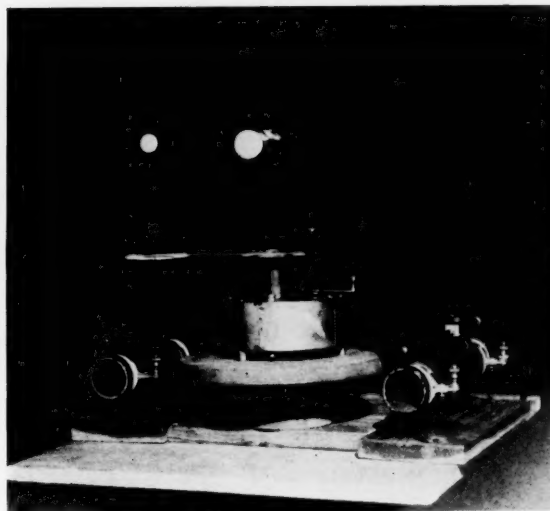
COMPLETION of Campbell Science Hall of Agnes Scott College makes possible demonstrations in physics and astronomy that I have long wanted to try. The building is one of considerable beauty and competency, but one feature which is especially useful is the length of the corridors. Moreover, the top floor, which is of chief interest to the department of astronomy, contains an attic at one end.

With its small door, the attic is a pretty good approach to a "black body." A light source placed in this attic can be viewed by telescope from the far end of the building. Experiments such as the one to be described can be performed during the hours of daylight without need of darkening the hall itself.

In the attic has been placed the artificial double star system illustrated here. It consists of apparatus to support two 7-watt frosted bulbs, one of which revolves about the other by a Telechron motor drive. The star revolves without rotating, to present the same illuminated area to the observer at the other end of the corridor. The orbit is 12 inches in diameter. Measured from a distance of 175 feet, the stars appear to be about 20 minutes of arc apart at their widest apparent separation.

An infinite number of combinations of relative total and surface brightnesses can be produced by means of rheostats. The relative sizes of the stars can be

A closeup view of the apparatus that produces the effects of an eclipsing binary system when viewed from a distance of 175 feet. On each side is located a rheostat for controlling "star" brightnesses. Photo by Dorothy A. Calder.



varied by changing the bulbs. Variations of inclination, showing total and partial eclipses, can be produced. Orbital eccentricity can be simulated by offsetting the fixed star. Limb darkening can be produced ranging all the way from that of Eskimos to that of Africans!

The other picture shows the observing apparatus, comprising principally a photric telescope (why always bother with "photoelectric"?) which traces the course of light variations. The telescope is an ordinary refractor of 60 millimeters aperture. The elbow telescope at

the right is used to inspect the stars, allowing relaxation by reducing the number of observations between eclipses.

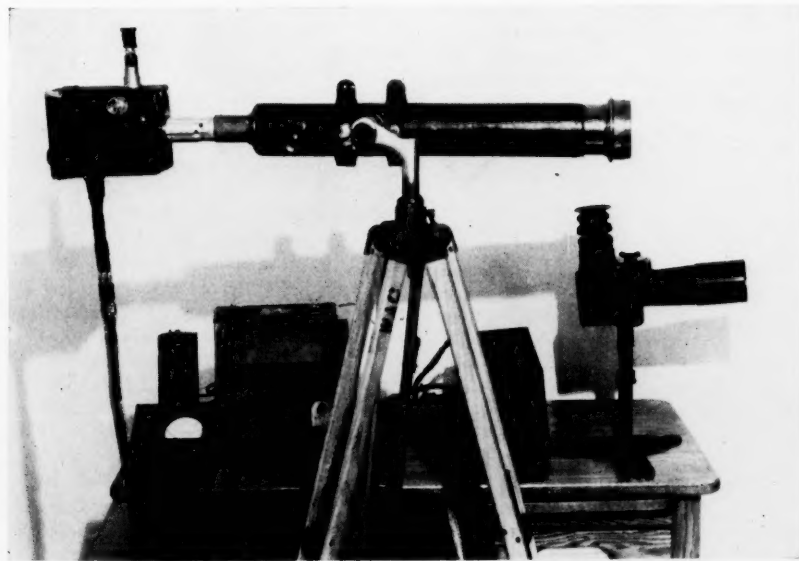
A 931A photomultiplier is used, and the output is fed into a one-tube amplifier. The photometer contains a retractable setting eyepiece made from a pentype microscope. The difficulty of feeding the light into the small window of the photocell with the stars at greatest elongation was overcome by using a plastic diffusing screen (Adlux film) placed two inches in front of the cell. In the focal plane of the telescope is mounted a Fabry lens to throw the image of the objective onto this screen.

The rheostat adjustments of the relative brightnesses of the stars can be made while viewing the microammeter from the stars, using another telescope placed beside the binary apparatus. It is a unique experience watching the eclipses from the stars!

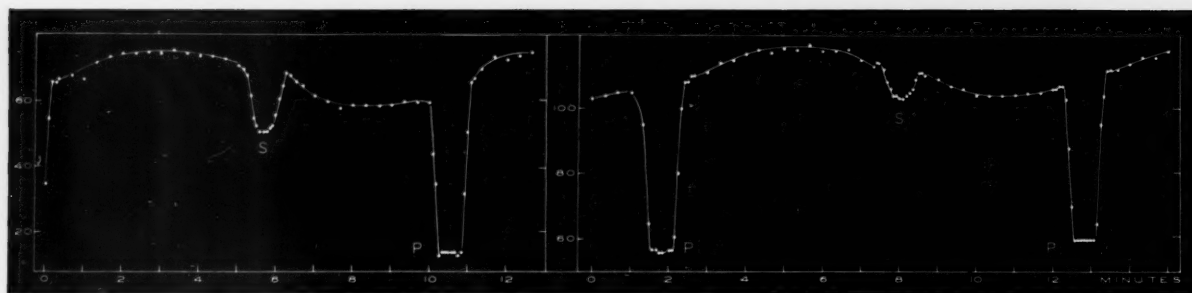
While an electronic recorder could be used in tracing the light variations, it is much better to afford students a lively time by having them read and record the current at five-second intervals during eclipses and at intervals of 20 seconds otherwise. Three microammeters are used in series, permitting three pairs of students to work simultaneously. A projection system is being devised so that a whole class can work at once.

The importance of eclipsing binaries needs no emphasis here, but this modern exercise has a zip not often found in so-called laboratory exercises in astronomy. Visual observations of the eclipsing stars are quite enjoyable, but tracing the alternate deep and shallow minima as registered on the meter is downright exciting.

*Note added in proof:* The accompany-



The apparatus by which the double star system at the other end of the corridor is observed, consisting principally of a small telescope equipped with a photoelectric cell, an amplifier, and a microammeter. The "finder" is the small elbow telescope at the right. Photo by Dorothy A. Calder.



Sample light curves from the Calder apparatus. At the left one star is an opal enlarging bulb; the other star is smaller and fainter. The secondary minimum is at S, with the small star in front of the larger. The round bottom shows the limb darkening of the large star. The primary minimum is at P, with the small star totally eclipsed; the minimum is flat. At the right, the small star's brightness has been increased, and S becomes shallower. In both cases, the orbit is somewhat eccentric, as indicated by the difference in time from P to S, compared with S to P. Superimposed on the curve is the sine curve of the change in distance (inverse-square law of brightness) caused by the sensible difference in the distance of the small star from the observer as the star revolved. The ordinates are microamperes.

ing light curves reveal effects in addition to the usual behavior of eclipsing stars. Variation between minima is due

to reflections, lack of voltage regulation of the lights, and even to the fact that the moving star is a foot nearer at one

point in the orbit than at the opposite. Later improvements bring the light curves into more nearly traditional form.

## TERMINOLOGY TALKS- J. HUGH PRUETT

### What Was the "Great Meteoric Procession"?

After the excitement about the meteors described last month was over, the question arose among astronomers as to the nature of this unusual meteoric display. Was it a meteor shower something like the Perseids of August, only of shorter duration? In that case, the objects seen near Bermuda and farther southeastward surely were not the same as those observed from Saskatchewan. Dr. Chant, writing during the next few years in several numbers of the *RASC Journal*, seemed sure the display had none of the characteristics of a shower. Had it been a shower, it seemed most likely it would have been witnessed far more widely.

The calculations of Dr. Chant convinced him that the fireballs were traveling almost parallel to the earth's surface. He surmised that they had been encircling the sun in a regular orbit, but had come so near the earth that they had been "captured" by it, and when seen by earth dwellers, were moving about our globe as actual satellites. It can be computed from the balance between gravitational attraction of the earth and the centrifugal force (some prefer centrifugal "tendency") of a moving body that a bullet fired horizontally near the earth's surface with a velocity of 4.9 miles per second would continuously encircle our world as a satellite—if the atmosphere were not present. (At 1,000 miles above the surface this velocity becomes 4.4 miles per second.)

Dr. Chant computed the height of the fireballs over Canada as around 26 miles. In a later article he raised this to 34 miles. He thought their speed, as referred to the earth's surface, was greater than five miles and less than 10

miles per second. At that time of night, meteors coming from the west were catching up with the earth in its orbital motion, so the apparent velocity was low. Had they been coming from the east, the ground speed would have been many times greater. The present writer has encountered both types in his meteor tracing.

W. F. Denning, of England, from calculations from the original observations, decided the meteors were at a height of about 38 miles when over the vicinity of Toronto and were traveling eight miles a second. He thought the bodies were probably not over 10 feet in diameter. Dr. Chant had placed their size far greater. Denning was convinced that at the beginning and ending of the visible flight the objects were higher than when nearer the midway point. The reports from the two ships previously mentioned were not obtained until long after many articles had been written on the subject. These later reports seemed to lengthen the known path from 2,500 miles to over 5,000.

Prof. W. H. Pickering, in four articles in *Popular Astronomy* of 1922 and 1923, agreed quite well with Dr. Chant. He was sure there were no shower characteristics detectable in the heavenly parade. He wrote that it was "a procession of fireballs in the same sky path going from horizon to horizon." He was fully convinced that the meteors seen off the eastern tip of Brazil were the same, or remnants of the same, as observed from Saskatchewan. He made the entire visible flight 5,659 miles and believed it continued several thousand miles farther. He considered them a "bunch of temporary satellites" which were "finally buried in the South Atlantic."

In *Popular Astronomy* of 1928, Willard J. Fisher raised the question as to whether the celestial visitors were the same bodies everywhere. He suggested that, on the contrary, the apparitions might have been local, and that too many uncertainties entered to be sure the bodies seen over Saskatchewan actually passed over other North American observers, Bermuda, and the ships.

Finally, in *Popular Astronomy* of 1939, Dr. C. C. Wylie, of Iowa State University, came out flatly against the long-flight, earth-satellite theory of some of the earlier writers. He showed that the data given by the more intelligent observers proved the event was a meteor shower, and that entirely different bodies were seen from widely separated localities. His calculation of the flight of what he calls the "detonating meteor" seen over Canada gave it a ground path of only a little over 100 miles. He considered that no clusters were seen to go "from horizon to horizon"; few if any bright meteors dropped below the skyline.

Professor Pickering had calculated that the atmospheric density at a height of 35 miles was only  $1/1,024$  of its value at sea level, so the resistance to meteoric flight would not be great. But Dr. Wylie showed that this is not the case, and proved that no single object could long endure at such heights in the atmosphere, thereby bringing an end to further speculations on the "great meteoric procession" of 1913.

The references consulted in preparation of this discussion include: *Journal of the Royal Astronomical Society of Canada*, 1913, articles beginning on pages 145, 404, 438, 443; 1914, 108, 112; 1915, 287; 1916, 294. *Popular Astronomy*, 1922, page 632; 1923, 96, 443, 501; 1928, 398; 1939, 291; the last is Dr. Wylie's article.

# The Variation of Latitude -- I

By OTTO STRUVE, *Leuschner Observatory*  
*University of California*

THE HIGH PRECISION of astronomical observations of star positions can perhaps best be understood when it is realized that the geographical latitude of a location on the earth is easily determined to within about 100 feet, even with a portable universal instrument. With modern instruments, such as the photographic zenith telescope pictured here, the latitude can be found to within about 10 feet. And if we are not interested in the *absolute* value of the latitude, but only in the differences between the latitudes of two or more observatories, located thousands of miles apart — even in opposite hemispheres — these differences can be ascertained to within about one foot!

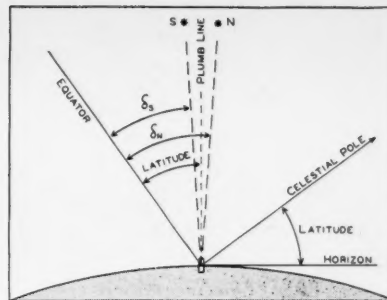
It seems almost unbelievable that it should be possible to measure angles with an accuracy of about one part in 100 million, but that is what the International Latitude Service is actually accomplishing, year after year, in its arduous task of determining the small movement of the earth's pole of rotation. One foot on the surface of the earth corresponds to about 0.01 second of arc, and there are more than a million seconds of arc along a complete meridian of 360 degrees. Hence, a precision of 0".01 corresponds to one part in  $10^8$ .

In principle, the determination of latitude is simple. It consists in measuring the angle of elevation of the celestial pole above the horizon. But in practice the task is not quite so simple. The horizon is not a well-defined feature upon which we can set the wire of a micrometer; and the pole of the heavens, determined, for example, as the center of the concentric circles described by circumpolar stars on a photograph made with a stationary camera, is affected by refraction, aberration, and other disturbing influences.

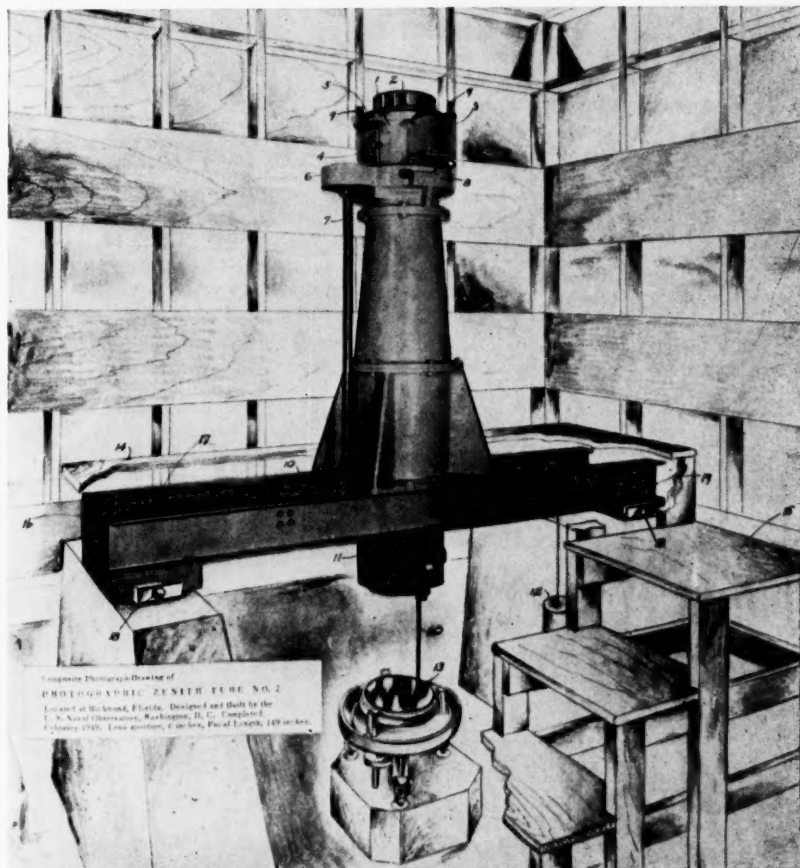
The method of determining latitude now in general use is one that was originally proposed in 1834 by Mr. Talcott, of the Corps of Engineers, U. S. Army. It consists in measuring the zenith distances of two stars at their culminations, one a little south of the zenith, the other the same distance to the north of the zenith. The zenith itself is found from the prolongation of the plumb line passing through the axis of the zenith telescope. The latitude of the place of observation is then the mean of the declinations of the two stars (corrected, if necessary, by one half the difference of their zenith distances, if the latter are not exactly the same). This method, perfected by F. E. Ross, who introduced

the photographic method of registration of the star passages, as well as by other astronomers, has many practical advantages. For example, it removes the refraction effect, which is the same but opposite in sense for the two stars; it eliminates the bothersome distortions caused by the flexure of the telescope when it is not placed in the vertical position, and so forth.

In Book I of Newton's *Principia* is the first theoretical prediction of a circular motion of the axis of a rotating



The principle of the determination of the latitude of a place from zenith telescope observations of stars. The mean of the declinations of stars S and N, one south of the zenith the same distance that the other is north, is the latitude of the telescope.



A composite photograph-drawing of the photographic zenith tube of the Richmond, Fla., station of the U. S. Naval Observatory, completed in 1949. Starlight passes through the 8-inch objective lens, focal length 149 inches, to the reflecting mercury surface at the bottom of the shaft, and comes to a focus on the small photographic plate located just below the objective. The numbered parts are: 1. Rotary. 2. Lens cell. 3. Photographic plate-drive mechanism. 4. Photographic plate access door (two, spaced 180°). 5. Level (two spaced 90°). 6. Rotary reversing gear cover. 7. Rotary reversing gear drive shaft. 8. 180° stops (two). 9. Setting microscopes (two spaced 180°). 10. Rotary reversing gear mechanism. 11. Telescoping hood (during operation the hood seats in the large basin). 12. Hood counterweight. 13. Mercury basin. 14. Operating platform (three sides). 15. Service steps. 16. Rotary reversing motor. 17. Rotary reversing motor brake. 18. Instrument orienting screws (four). 19. Instrument leveling screws (3). 20. Focusing rod (lifts automatically when hood is lowered). Official U. S. Navy photograph.

body. In Florian Cajori's 1934 translation of the *Principia* we read:

"Suppose a uniform and exactly spherical globe to be first at rest in a free space; then by some impulse made obliquely upon its surface to be driven from its place, and to receive a motion partly circular and partly straight forward... it is manifest that by its own force it will never change its axis, or the inclination of its axis... But let there be added anywhere between the pole and the equator a heap of new matter like a mountain, and this, by its continual endeavor to recede from the center of its motion, will disturb the motion of the globe and cause its poles to wander about its surface describing circles about themselves and the points opposite to them. Neither can this enormous deviation of the poles be corrected otherwise than by placing that mountain either in one of the poles...; or in the equatorial regions...; or, lastly, by adding on the other side of the axis a new quantity of matter, by which the mountain may be balanced in its motion."

Let us apply these ideas to the earth. Somehow, as the result of cosmogonical causes, the earth originally became endowed with a rotation around an axis that may be considered fixed in space, except for the disturbing action of the sun, moon, and planets. Now, if the earth was spherical to begin with, the rotation would be uniform and there would be no change of latitude. But if there was an unsymmetrical distribution of mass to begin with, or if (as a result of geological and meteorological phenomena) such a distribution should be brought about at a later date, the rotation would no longer remain uniform.

The unsymmetrical body of the earth would begin to readjust itself on its axis, because the "heap of new matter" would produce an excess of centrifugal force and would try to move away from the original axis of rotation. It would try to approach the equator but, as in the case of a spinning top, would never succeed in getting there. Instead, the matter would describe a circular motion and, being firmly attached to the earth, would compel the latter to execute a gyration around the fixed axis. Thus, it is the earth itself that wobbles around the fixed axis—the latter retains its orientation with respect to the universe outside. This motion of the earth is described as the *variation of latitude*.

The reader should take great care to distinguish between variation of latitude and the other wobbly motions of the earth—precession and nutation—from which it differs fundamentally. The latter are produced by the attraction of the moon and sun upon the equatorial bulge of the earth. This causes forces which try to tilt the earth,

with its axis included, into the plane of the ecliptic. And again, because of the gyroscopic interaction of the earth's own rotation and this extra rotational motion at right angles to the former, the final result is a gyration of the earth with its axis. But in precession and nutation the latitude of every place on the earth remains unaffected—instead, the prolongation of the earth's axis, which defines the celestial pole, describes a path among the stars requiring 25,800 years for one cycle; there would be no conspicuous change in the climate.

On the other hand, if the variation of latitude were large enough, it would involve a slow change in climate. But the asymmetry of the mass distribution in the earth is so small (compared with its total mass) that the variation of latitude is not large enough to have any effect on climate. As mentioned parenthetically above, variation of latitude is believed to be due to changes in the distribution of air masses over continents and oceans, and to the continuous rearrangement of material inside the earth's crust; these can cause essentially the same kind of disturbance as Newton's "heap of new matter."

Although Newton had predicted an apparent circular motion of the pole on the surface of the earth, he did not determine its period. This was done by Leonhard Euler in 1765. Assuming that the earth is a rigid body, he found the period to be 304 days.

The first successful attempt to measure the variation in latitude was made in 1842-43 by Peters, at Poulkovo. Later observations at Poulkovo, Greenwich, and elsewhere, confirmed Peters' discovery that the latitude of each observatory undergoes changes of the order of half a second of arc, but there was no exact confirmation of Euler's period, and the whole question remained in suspense. Interest in it was revived by the

painstaking work of Kuestner at Berlin who, in 1888, established that "the latitudes of Gotha, Berlin and Poulkovo had each fluctuated to the extent of a few tenths of a second of arc within about one year."

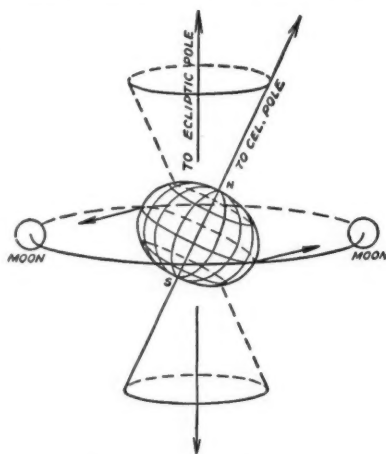
But this did not yet prove that the earth really wobbles in the manner predicted by Newton and Euler. It might be possible that there are small relative displacements of the continents against each other, in the manner of the theory of "floating continents" by Wegener. In order to be certain whether the earth wobbles as a whole, it was necessary to determine the variation of latitude at observatories located about 12 hours (180°) apart in longitude. Then if, for example, the latitude in America increased, there should be a corresponding decrease of the latitude in central Asia.

This crucial test was made in 1891 by the International Geodetic Association and the U. S. Coast and Geodetic Survey. Observations were made at several stations in Europe, the United States, and Waikiki, in the Hawaiian Islands. The last station was removed about 180 degrees in longitude from the European observatories and was thus especially important. The test showed conclusively that the latitudes of Waikiki and Europe changed in the opposite direction.

At about the same time S. C. Chandler, of Cambridge, Mass., started a long series of investigations of the variation in latitude. He found that the effect could be traced as far back as the time of Bradley, 175 years earlier, and that many discouraging discrepancies in the astronomical observations were actually due to changes in the latitudes of the observatories.

Still more important was his conclusion that the period of the variation is not 304 days, as predicted by Euler, but 428 days (or 14 months). This discrepancy was explained in 1892 by S. Newcomb, who showed mathematically that a departure of the earth from absolute rigidity would tend to increase the period. In fact, from the observed period, and from simultaneous observations of tidal changes in the force of gravity, the rigidity of the earth, as a whole, is found to be about twice that of steel. Yet, it is the slight departure from perfect rigidity that causes the difference between Chandler's period and the one predicted by Euler.

After several international conferences were held in the 1890's it was decided to organize an International Latitude Service of six participating observatories, located in about the same latitude but in different longitudes, and equipped with similar zenith telescopes. In the United States the observatories at Ukiah, Calif., Gaithersburg, Md., and Cincinnati, Ohio, took part in this pro-



This diagram illustrates precession—the gyration of the earth together with its axis—which is not to be confused with the variation of latitude. From "Astronomy," by Robert H. Baker.

gram. The Russian observatories of Tchardjuy and Kitab are located about 180 degrees in longitude from the American observatories. Without the co-operation of these stations the work could not have been carried forward. Fortunately, in 1899, when observations of the same list of stars were started at the various stations, there was no major war in progress. However, later wars did interrupt the work at some of the stations, causing irreparable damage to a part of the program. In the main, however, the program has been continued to this day.

The earlier results were discussed by B. Wanach at the Potsdam Geodetic Institute. Later the central bureau of the service was transferred to Mizusawa, Japan, with H. Kimura as the head. Still later, the supervision of the work was entrusted by the International Astronomical Union to Luigi Carnera, of Naples and Carloforte, Italy. Since the retirement of Professor Carnera, the central bureau is being headed by G. Cecchini, of Turin.\*

(To be concluded)

\*A general account of the problem of varia-

tion of latitude was published in 1931, by W. D. Lambert, F. Schlesinger, and E. W. Brown, as Chapter 16 of "Physics of the Earth, II: The Figure of the Earth" (Bulletin, National Research Council, No. 78, 1931). More recent summaries have appeared in the Russian language: K. A. Kulikov, The Motion of the Poles of the Earth and the Variation of Latitude (*Ouspekhi Astr. Nauk.* 3, 111, 1950) and E. P. Feodorov, Basis of Modern Theory of the Motion of the Poles of the Earth (*Publ. Poltava Gravimetric Observatory*, 2, 1948). There have also been regular reports of the Commission on Latitude Variation (No. 19) in the *Transactions of the IAU*, and a summary by G. Cecchini, "Variazioni delle Latitudini Terrestri e Fenomeni Geofisici" (*Geofisica Pura e Applicata*, Milano, 18, 1950).

## The Meaning of Alphecca

BY GEORGE A. DAVIS, JR.

FROM time immemorial, it has been assumed by all writers on the constellations that the Arabic name of Corona Borealis, *Al-Fakka*, meant "bowl," "dish," "platter," or an earthenware vessel of some kind. As-Sufi, of course, in his great work, *The Stars and Constellations*, written in A.D. 964,<sup>1</sup> was the first writer to make this name known to non-Arabic-speaking peoples; and it is interesting to note that his translator admitted that "On ne connaît pas exactement le sens de cette dénomination."

Qazwini, later, in his work commonly known as the *Cosmography*, written in 1262, mentions *Al-Fakka* as the name of "one of the northern constellations, having a circling form, but with a gap or breach in the circling, behind the staff of *As-Sayyah*," one of Bootes' names.<sup>2</sup>

Ulugh Beg, in his *Star Catalogue* of 1473, and At-Tizini, in his *Tables of the Fixed Stars*, of 1533,<sup>3</sup> also called the constellation by the same name; but none of the foregoing writers, naturally, gave any indication of the meaning of the designation, assuming such knowledge on the part of the astronomers, even though the name, as applied to a group of stars, was a rather remarkable and extraordinary one.

Ideler,<sup>4</sup> the father of modern research on the constellations and star names, is not at all sure of the meaning. He wavers between the correct root word, which he is unable to convert into a proper name with its correct meaning, and the translation of the word as "die Bettlerscherbe," the beggar's vessel, which he states is "die wahre Bedeutung." He also says that "the Persian *Kase derwischan*" is equivalent to "the Arabic *Al-Fekka*."

William Henry Smyth,<sup>5</sup> whom Allen and others quote extensively without always giving full credit to the admiral, stated that "the most usual name of the constellation is Alphecca, from *Al-fekkah*, the dervish's cup or platter, from the break in the ring of stars."

Then Richard Hinckley Allen,<sup>6</sup> who

is partly responsible for my interest in ancient astronomy, with more courage than discretion, and feeling that he was well fortified by Ideler and Smyth, translated the name as "the dish"; and he has been followed in this error by all who have written on the constellations since the publication of his great work.

William Tyler Olcott<sup>7</sup> very naively informs us that Alphecca means "the bright one of the dish." The Rev. Charles Whyte<sup>8</sup> follows Allen and Olcott. And so with many others. Thus we find the meaning to be "the dish or platter" or "the bright one" in all the modern works on the constellations.

In my article on star names, written in 1944,<sup>9</sup> I stated that *Al-Fakka* meant "the broken or fractured one," and that it did not mean "the dish." The implication contained in this translation was correct, but I had one step farther to go. At that time it was impossible for me to secure all the Arabic authorities I sought to consult. I trust that I have now remedied that omission.

*Al-Fakk*, according to Ar-Raghib al-Isfahani, primarily signifies *at-Tafrij*, "the opening of a thing," particularly by diduction, or separation, so as to form an intervening space, gap, or breach. For example, *Fakka* means, "he separated one thing from another," and *Fakak-tuhu*, "I separated one part of it from another part thereof"; and *Tafkik* signifies the separation of two things knit together or intricately intermixed.

*Qad fakka wa faraja* is said of a very old man, meaning *Faraja lahayihi*, "he has parted his jaws," by hanging the lower jaw in consequence of weakness, as is the case in extreme old age. And hence *Fakka*, in this sense (the infinitive nouns being *Fakk* and *Fukuk*), means, "He was extremely aged, or old and weak."

And, finally, *Qad fakikta*, a verb of very rare form (the infinitive nouns being *Fakka* and *Fakk*), means, "Thou hast become soft, flaccid, feeble, or languid."

The above discussion will be found in Lane, *ibid.*, VI, 2430.

*Al-Fakka*, or, as some Arabic scholars prefer, *Al-Fakkah*, means, therefore, "The feeble, flaccid, or languid one," because it had not the strength to prevent its circle of stars from being broken.

The Arabic and Persian popular names of the constellation, which include the word for "dish" or "bowl," are:

*Qas' at al-Masakin*, "the bowl of the beggars," and *Qas' at as-Sa'alik*, "the bowl of the poor or indigent," are the Arabic names, and *Kasa'i Darweshan*, "the beggar's dish," *Kasa'i Shikasta*, "the broken dish," and *Kasa'i Yatiman*, "the orphan's dish," are the Persian names.

### REFERENCES

1. Translated by H. C. F. C. Schjellerup, St. Petersburg, 1874, under the title *Description des Etoiles Fixes*. The discussion of Corona Borealis will be found on page 69.
2. See Edward William Lane, *An Arabic-English Lexicon*, London, 1863-1893, VI, 2431, and partly translated by Ideler.
3. Thomas Hyde, *Syntagma Dissertationum*, Oxford, 1665, second edition by Gregory Sharpe, I, 21-22, 105, 1767; *Memoirs of the Royal Astronomical Society*, XIII, 84, 1843.
4. *Sternnamen*, 57-61, 305, 1809.
5. *A Cycle of Celestial Objects*, II, 346, 1844.
6. See his *Star-Names and Their Meanings*, 176, 1899.
7. *Star Lore of All Ages*, 153, 1911.
8. *The Constellations and Their History*, 172, 1928.
9. *Popular Astronomy*, LII, No. 1, 1944.

### LETTERS

Sir:

In answer to the letter from R. G. Chandra, published on page 59 of the January issue, see J. K. Fotheringham's article on the calendar which was included in the "Explanation" to the *British Nautical Almanac* during 1931-38; and Solomon Gandz, "The Origin of the Planetary Week," *Proceedings, American Academy for Jewish Research*, 18, 213-254, 1949. The names of the seven "planets" of the ancients were attached to the 24 hours of the day as rulers of these hours, in order of decreasing distance from the earth in the ancient Greek geocentric system; the planet that ruled the first hour was the ruler of the day, and the day was named after this planet.

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# NEWS NOTES

## VARIABLE WITH SHORTEST KNOWN PERIOD

On January 28th, the University of California announced that Dr. Olin J. Eggen, Lick Observatory astronomer at present working at the Commonwealth Observatory, Canberra, Australia, had discovered the variable star HD 223065 to have the shortest period known — 80 minutes. The discovery was made using photoelectric equipment designed by Dr. Gerald E. Kron, who is with Dr. Eggen in Australia.

In his technical report in the February, 1952, *Publications of the Astronomical Society of the Pacific*, Dr. Eggen states that the range of magnitude variation appears to be different in every cycle; it may be as large as 0.8 or as small as 0.3 magnitude. The changes in the form and brightness of the maximum are strikingly similar to those found previously by Walraven for RR Lyrae during various phases of its 41-day secondary period. Kuiper and Joy class the star as a subdwarf, and its color at minimum corresponds to A8 or F0.

The nature of this 7th-magnitude star throws doubt on the validity of the assumption that rapidly varying stars of the RR Lyrae (cluster) type have absolute photographic magnitudes of 0.0, for then the star's distance would have to be of the order of 265 parsecs (uncorrected for absorption). Its proper motion of 0.886 second of arc per year would then give a tangential velocity of 1,110 kilometers per second, which exceeds the velocity of escape from the galaxy.

On the other hand, the trigonometric parallax of the star gives a distance of only 37 parsecs and an absolute magnitude of +4.3, and this "seems equally absurd for an RR Lyrae variable," states Dr. Eggen. He suggests that either the star is a different type of variable or that the RR Lyrae variables of shortest period have low luminosities.

At the McCormick Observatory, University of Virginia, Dr. A. N. Vysotsky recently discovered another rap-



Part of an objective-prism plate taken with the 8-inch Bache doublet at Harvard Observatory's station, Arequipa, Peru, September 11, 1899. Each spectrum is composed of adjacent strips of about 10 minutes exposure each. These strips are of fairly uniform intensity, but Eggen's star (left center) shows a minimum and two maxima in the total exposure time of 110 minutes. Harvard Observatory photograph.

idly varying star by observing the changes in density across a widened spectrum (*Sky and Telescope*, November, 1950). Harvard plates were therefore examined for a similar effect with Eggen's star. One of these, of more than 50 years ago, is reproduced here, its nearly two-hour exposure showing the star's variation in light, and the original plate revealing changes in the most prominent spectral features, such as the K line of calcium. The spectrum is classified as A0 in the Henry Draper Catalogue.

The record for the shortest period heretofore has been held by CY Aquarii, with a period of 88 minutes. The new variable is No. 223065 in the Henry

Draper Catalogue, and its 1950 position is  $23^{\text{h}} 43^{\text{m}}.8$ ,  $-42^{\circ} 23'.5$ , a few degrees from Iota in the constellation of Phoenix. It appears to be plotted in the Skalnate Pleso *Atlas of the Heavens*.

## VATICAN DIRECTOR DIES

Father John W. Stein, S.J., director of the Vatican Observatory since 1930, died in Rome December 27, 1951. He was born in 1871 in Holland, and began his study of astronomy at the University of Leiden. He was assistant at the Vatican Observatory from 1906 to 1910, publishing studies of eclipsing binaries. Then 20 years of his life were devoted to teaching mathematics, physics, botany, and zoology in Amsterdam, although in that period he published a work on variable stars and became editor of the astronomical journal of the Dutch association of amateur astronomers.

As director at the Vatican, Father Stein devoted his energy to modernizing the equipment and enlarging the staff. In 1932 he founded an astrophysical laboratory, and in 1933 constructed a new observatory at Castel Gandolfo. He continued his own visual observations of variables and doubles until his 78th year.

## LONGEST STELLAR ECLIPSE

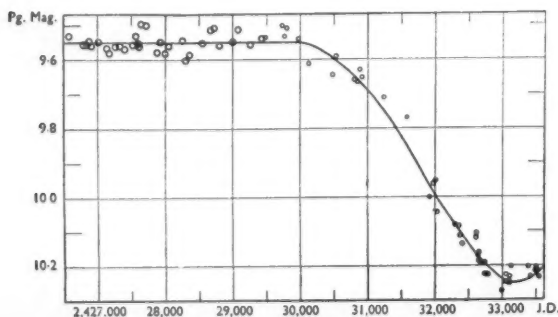
A very unusual eclipsing variable star has been discovered by the Rev. D. J. K. O'Connell, at the Riverview Observatory, New South Wales, who describes his observations in the *Monthly Notices of the Royal Astronomical Society*. The star (CPD  $-60^{\circ} 3278$ ), about magnitude 9.5 photographic at maximum brightness and 10.25 at minimum, is in the constellation Centaurus at declination  $-60^{\circ}$ .

Thus far only about two thirds of one eclipse has been observed, but its duration will be at least 17 years. The curve drawn by Father O'Connell shows a partial eclipse, with mid-eclipse at JD 2,433,200. It is possible that a total phase began about JD 2,433,000, but the next year or two should show whether the eclipse is partial or total.

A search backward indicates that no previous primary minimum occurred since about 1884; thus the period of complete revolution of the double star is at least 65 years, and it is more likely of the order of 200 years. By analogy with long-period visual binaries, the orbital eccentricity is probably greater than 0.5.

This is probably the longest-period eclipsing star on record, its closest runner-up being S Doradus (also in the southern skies) with a period of 14,670 days (40 years).

Harvard observations extending back to 1890 reveal an unsymmetrical mini-



The light curve of the star CPD  $-60^{\circ} 3278$ , by Father O'Connell, 1939 to 1950. The circles denote mean points, the area of each circle being proportional to its weight. Reproduced from "Monthly Notices" of the Royal Astronomical Society.

mum between about 1901 and 1917 some 0.2 magnitude fainter than the normal maximum brightness (note by S. Gaposchkin, *Publications, Astronomical Society of the Pacific*, April, 1951, page 80). If this is indeed an eclipsing system, it must have properties as unusual as those of S Doradus to account for the long duration of the minimum.

## EARTHQUAKE RECORDERS ON PALOMAR MOUNTAIN

New equipment at the Palomar Mountain seismological station of California Institute of Technology will make it one of the best earthquake recording units in the world, according to an announcement by Dr. Beno Gutenberg, director of Caltech's seismological laboratory. All of the instruments, including a magnetic tape to make audible amplification of earthquake records, are the invention of Dr. Hugo Benioff, also of Caltech. The Palomar station is one of 13 scattered throughout southern California in the Caltech seismological network.

There will be two electromagnetic linear strain seismographs, set at right angles to each other. Each consists of a 2½-inch quartz tube suspended by flexible supports throughout its extent between two piers embedded in rock. The tube is fastened to one pier, its free end close to the other pier. Microscopic changes in the distance between the piers, caused by seismic waves, actuate an electromagnetic recording device. Each of these seismographs at Palomar will be 150 feet long, instead of 20 and 60 feet as are earlier models operating in Pasadena. These latter have recorded not only the footsteps of a person walking through the laboratory, but also compression of the rock beneath it resulting from the person's weight. At Palomar, the strain seismographs will be set up at the south end of the mountain-top, more than half a mile from human disturbances.

The tape recorder is operated with a pendulum seismograph. The tape is run at about ½ millimeter per second (requiring attention only once a week), played back at 15 inches per second, and the resulting speedup is about 600 times. This corresponds to the average acceleration in the usual motion pictures of prominence action on the sun. When quakes go past 600 times faster than they were recorded, a local shock sounds like a pistol shot and a distant quake like a strike in a bowling alley.

## IN THE CURRENT JOURNALS

TREE RINGS AND SUNSPOTS, by J. H. Rush, *Scientific American*, January, 1952. "Concerning the lifework of A. E. Douglass, who applies the regular variation in the growth pattern of conifers to the investigation of solar cycles and human history."

# Amateur Astronomers

## THIS MONTH'S MEETINGS

**Buffalo, N. Y.:** Amateur Telescope Makers and Observers, 8 p.m., Museum of Science. March 5, Ruth Northcott, David Dunlap Observatory, "The Velocities of the Stars."

**Cambridge, Mass.:** Bond Astronomical Club, 8 p.m., Harvard Observatory. March 6, Dr. I. B. Cohen, Harvard University, "Newton's Ideas on Gravitation."

**Cleveland, Ohio:** Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. March 14, Dr. Fred L. Whipple, Harvard Observatory, "Comets and Meteors."

**Dallas, Tex.:** Texas Astronomical Society, 8 p.m., Dallas Power and Light Co. auditorium. John Hulme, "Chemistry Related to Astronomy."

**Denver, Colo.:** Denver Astronomical Society, 8 p.m., Chamberlin Observatory. March 10, astrophysics group program; election of officers. March 24, annual banquet.

**Geneva, Ill.:** Fox Valley Astronomical Society, 8 p.m., Geneva City Hall. March 11, Prof. Clarence R. Smith, "Pages from the History of Astronomy."

**Greensboro, N. C.:** Greensboro Astronomical Club, 8 p.m., Science Building, Woman's College. March 12, Mrs. John Bradshaw, "Meteors and Meteorites."

**Indianapolis, Ind.:** Indiana Astronomical Society, 2:30 p.m., Riley Library. March 2, Russell Sullivan, "Astronomical Recollections."

**Lorain, Ohio:** Black River Astronomical Society, Lorain-Elyria, 8 p.m., Lorain YMCA. March 11, W. L. Sipple, "Galileo."

**Madison, Wis.:** Madison Astronomical Society, 8 p.m., Washburn Observatory. March 12, Dr. Arthur D. Code, Washburn Observatory, "What Is a Star?"

**Minneapolis, Minn.:** Minneapolis Astronomy Club, 7:30 p.m., Library Science Museum. March 5, D. C. Dornberg, review of Hoyle's *Nature of the Universe*. March 19, Sherman Schultz, "Amateur Astronomical Photography."

**New York, N. Y.:** Amateur Astronomers Association, 8 p.m., American Museum of Natural History. March 5, Dr. Lyman Spitzer, Jr., Princeton University Observatory, "Matter in Space."

Junior Astronomy Club, 8 p.m., American Museum of Natural History. March 21, junior competition; elections.

**Rutherford, N. J.:** Astronomical Society of Rutherford, 8 p.m., YMCA. March 6, Richard T. Carrico, "Celestial Navigation."

**Teaneck, N. J.:** Bergen County Astronomical Society, 8:15 p.m., Observatory, 107 Cranford Pl. March 12, William A. Miller, "Variable Stars and Observing Techniques."

**Washington, D. C.:** National Capital Astronomers, 8:15 p.m., Commerce Building auditorium. Dr. Thornton Page, Operations Research Office, Johns Hopkins University, "The Masses of the Galaxies."

## L.A.A.S. 1952 OFFICERS

At the final 1951 monthly meeting of the Los Angeles Astronomical Society, the following officers were elected to serve in 1952: president, L. F. Mawhinney; vice-president, Ray Stolle; secretary-treasurer, Carl Langevin; recording secretary, Eugene Epstein.

The retiring president, Dr. Homer P. King, will serve on the new board of directors, which also includes James M. Garrett, Frank T. Grow, Clark Harris, Chalmers Myers, Dr. Harold Miller, Judge Ben S. Beery, and Dr. Robert S. Richardson.

## HOUSTON PLANETARIUM PROGRAM

A three-fold program of activity is under way at the University of Houston, Texas, where the Spitz planetarium installation is used for elementary astronomy instruction in the college curriculum, for school groups, and for public demonstrations.

Since late 1950, 4,200 school children have visited the planetarium in its 17-foot dome. The school children's program opens with a motion picture, followed by the planetarium demonstration, a question and answer period, and a visit to the 73-foot Foucault pendulum. Each program lasts about an hour, and transportation is provided for school groups in and immediately around Houston. Arrangements

may be made through Dr. Robert Warren Long, chairman of the department of physical science at the University of Houston, who is in charge of the planetarium project.

Public astronomy lectures are also offered on the first Tuesday of each month, at 8 o'clock in the science building. These include a planetarium demonstration, motion pictures, and observing. On March 4th the topic will be "Meteors, Comets, and Eclipses"; on April 1st, "Earth and the Solar Family"; and on May 6th, "The Sun as a Star."

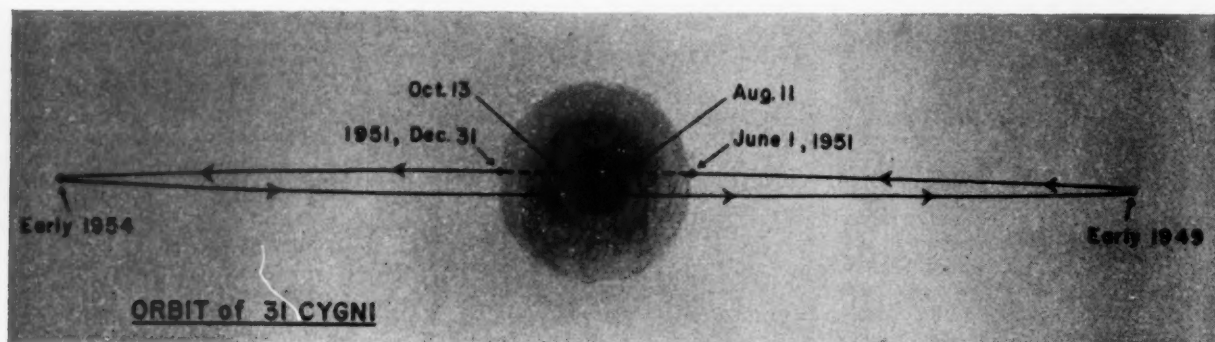
## SOUTH BEND ASTRONOMY GROUP

Following several years of inactivity, reorganization of the St. Joseph Valley Astronomers in South Bend, Ind., took place January 7th, through the efforts of Francis K. Czyzewski, who originally organized the club in 1937. Paul Godollei, a past president, was elected to head the group. Robert Carr was named vice-president; Irma DeBruycker, of Mishawaka, Ind., secretary; Janice Waltz, also of Mishawaka, treasurer.

The club will help instruct boy scouts, cub scouts, and other interested groups in elementary astronomy, and a class in telescope making, popular in prewar days, was put on the immediate agenda. The group is meeting on the first Monday of each month at 8 o'clock at the Hotel LaSalle, South Bend.

# AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 86th meeting of the American Astronomical Society at Cleveland, Ohio, in December. Complete abstracts will appear in the *Astronomical Journal*.



The relative orbit of 31 Cygni. Seven months are required for the complete primary eclipse, during which the blue star passes behind the extensive atmosphere of the orange primary. It is the light of the blue star "probing" the atmosphere of the supergiant that reveals its nature and composition. Drawing by Dominion Astrophysical Observatory.

## The Eclipse of 31 Cygni

The 4th-magnitude star 31 Cygni (Omicron<sup>1</sup>) is double, consisting of a "small" hot star (class B8) with a surface temperature of about 18,000° absolute and a diameter about five times that of the sun, and a supergiant cool star (K0) of less than 4,000° but 150 times the diameter of the sun. Long known as a spectroscopic binary, this star's nature as an eclipsing double star was discovered in 1950 by Dr. Dean B. McLaughlin, University of Michigan Observatory, on spectrograms taken in 1941.

As with all binaries, these stars circle about one another under the influence of their mutual gravitation, and the period of revolution in this case is 10 years and five months. Dr. McLaughlin found that the plane of the orbits was close enough to the line of sight from the earth that the two stars in

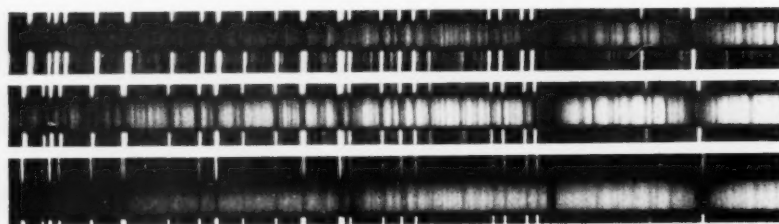
their orbital motion might eclipse one another. He predicted an eclipse or near-eclipse to take place during 1951. This was to be, however, no ordinary event, for 31 Cygni is perhaps the best example of eclipsing systems with extended atmospheres, the others being Zeta Aurigae, VV Cephei, and 32 Cygni. The Michigan astronomer described observations of Zeta Aurigae in *Sky and Telescope*, July, 1948.

Although the hot star of 31 Cygni was not scheduled to pass behind the solid body of the K star until August or September, astronomers at the Dominion Astrophysical Observatory, Victoria, B. C., began taking spectrograms as early as possible in the spring of 1951. No change in brightness was noticed at first, but the spectral K line of ionized calcium, caused by the light of the blue star shining through calcium high in the atmosphere of the cool star, was definitely detected by June 2nd. It

became more intense, but only slowly, through June and early July. Between July 16th and 26th, the line became much wider and assumed a rectangular profile, which broadened slowly and acquired wings on the last few days before totality. About August 1st, lines of iron and other elements in the cool star's atmosphere began to show up strongly in the spectrum of the B star shining through.

Total eclipse, with the hot star behind the opaque body of the cool one, began on August 11th and lasted until October 13th. Thus, the dense part of the large cool star is big enough to hide its companion for 63 days, in spite of the fact that the stars pass one another at a relative speed of 25 miles per second. Therefore, the giant star is at least 135 million miles in diameter, large enough to fill the orbit of Venus. But the extent of its atmosphere is about 390 million miles. The two star centers are separated by some 1,200 million miles, and their distance from us, according to the Mount Wilson spectroscopic parallax, is 500 light-years.

As with Zeta Aurigae, the relatively slow passage of the hot, bright star behind the atmosphere of the cool primary of 31 Cygni gives astronomers an unusual opportunity to study the nature of the primary's extensive envelope of gases. After the eclipse had ended, during November and December, the Victoria astronomers observed with a powerful grating spectrograph, to find the K line of calcium (and also the H line) strangely variable. The line appeared both single and double, with the components changing in intensity, even in one or two days. These changes are interpreted as proving the presence of discrete clouds of ionized calcium vapor high in the K star's atmosphere, 75 to



Spectra of 31 Cygni taken by Dean B. McLaughlin. Top: October 10, 1951, when the blue star was totally eclipsed and only the cool star's spectrum was seen; it is weak in the violet. Center: October 13, 1951, while the blue star was emerging; the strong dark lines were produced by gases in the atmosphere of the cool star absorbing the light of the blue star. Bottom: October 18, when the hot star had emerged from the deepest layers of the supergiant's atmosphere; many of the lines produced by the deepest layers had faded away, and the prominent calcium lines had lost their wide hazy wings. The spectra are not printed to quite the same scale; the comparison bright lines are from an iron spark. The calcium H and K lines are  $\frac{1}{4}$  and  $1\frac{1}{2}$  inches from the right-hand edge.

University of Michigan Observatory photographs.

150 million miles above the star's surface. Doppler shifts differing by 20 to 37 kilometers per second revealed motions of these calcium clouds.

The occurrence of great prominences or even "fields of prominences" in the extended atmospheres of giant stars has been suggested by several astronomers. The 31 Cygni phenomena seem to demonstrate this fact with more certainty than any previous observations.

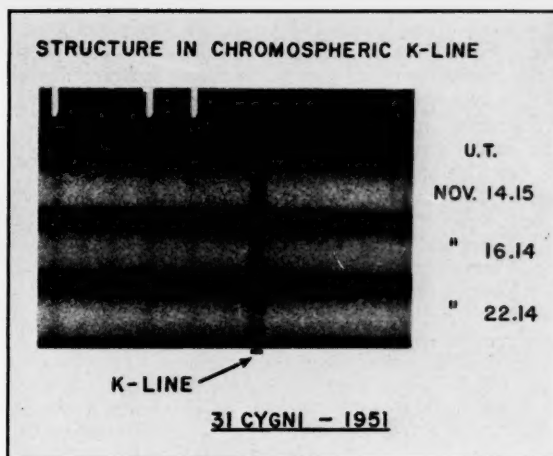
The work at Victoria was reported by Dr. Andrew McKellar, Dr. L. H. Aller (University of Michigan), and G. J. Odgers, but all members of the Victoria staff took part in the study of 31 Cygni.

At the University of Michigan, Dr. McLaughlin sought to determine the rotation of the *K* star's atmosphere, but found instead, from the lines of iron and other elements, evidence for strong currents at various levels. Five to six weeks after October 13th, when all lines due to the eclipse had disappeared but those of ionized calcium, the latter were displaced toward the red by 12 miles per second—possibly as a result of prominence motions.

Dr. McLaughlin compared 31 Cygni with the other supergiant eclipsing binaries, two of which, 32 Cygni and VV Cephei, had also been discovered at Michigan. The structure of all four supergiant atmospheres is very similar. The spectra of equivalent stages can be readily identified in all four, with only slight outstanding differences, but the time scales are quite different. The stages of atmospheric eclipse take only 10 days for Zeta Aurigae (period  $3 \frac{2}{3}$  years),  $3\frac{1}{2}$  times this long for 31 Cygni, five times as long for 32 Cygni, but 50 times as long for VV Cephei. Although the period of the last of these is only 20 years, the cool component of VV Cephei has a much more extensive atmosphere in comparison with the star itself than do the others. VV Cephei is a red, class *M* star, with a diameter over 1,000 times that of the sun.

The spectroscopic observations of a variable star, however, need to be supplemented with its light curve, in different colors. Photoelectric photometers were used by Dr. F. Bradshaw Wood at the Flower Observatory, University of Pennsylvania, and Dr. E. F. Carpenter at the Steward Observatory, University of Arizona, to measure the changing total light of 31 Cygni during its eclipse. Because the blue star was hidden, the eclipse dimming was greater in blue light, 0.36 magnitude, than in yellow light, 0.15 magnitude, according to observations by Dr. Wood and Dr. William Blitzstein. In the near ultraviolet (wave length 3600 angstroms), the eclipse amounted to 1.4 magnitudes. Dr. Carpenter observed in the blue, yellow, and ultraviolet.

The manner in which the calcium K line in the atmosphere of the supergiant component of 31 Cygni changed while the blue star continued in atmospheric eclipse. Dominion Astrophysical Observatory photo.



### Short-arc Comet Orbits

When a comet appears, it is desirable as soon as possible to make preliminary computations of its path in order that observers may be notified of its approximate future whereabouts in the sky. Dr. Allan D. Maxwell, Howard University, has developed a simplified method, requiring only four-place logarithms or a 20-inch slide rule, to obtain a short-arc preliminary parabolic orbit where three observations spaced at approximately equal intervals are available.

The procedure entails the use of differences of given quantities, rather than the quantities themselves. A seven-place table of natural functions is needed at the outset, to find sines and cosines of the three right ascensions and declinations involved, but this table is not used again. In the case of Comet 1951a (Pajdusakova), the slide rule computation gave a good search ephemeris for more than 30 days ahead of the two-day interval on which the orbit was based.

### Meteor Masses and Densities

For a number of years, observations of meteors have been used in finding the density of the upper atmosphere. Now rockets probe these heights and make it possible to reverse the procedure to obtain better values of the masses and densities of the meteors themselves. Dr. Fred L. Whipple, of Harvard Observatory, has compared two methods, one involving the drag of the atmosphere on a meteoroid, the other the brightness, depending upon the luminous efficiency of the meteor. The two methods cannot be brought into general agreement unless certain basic assumptions are changed.

Dr. Whipple concludes tentatively that meteoroids of cometary origin are of very much lower density than those of the meteoritic type (slow photographic meteors with asteroidal-like orbits). While the latter may be as dense as three grams per cubic centimeter, the cometary meteors range from only 0.2

to 1.0 gram per cubic centimeter, that is, up to the density of water. The mass of a meteor of visual magnitude zero is about 1.25 grams at a mean velocity of 40 kilometers per second.

The low density fits with Dr. Whipple's icy conglomerate model of comets. An original meteoroid possibly consists of a large fraction (perhaps 0.7 to 0.8 by mass) of ices, which would be sublimated by the sun's radiation. The resulting meteoroid entering our atmosphere would be a porous fragile structure of meteoritic materials.

### Solar Enhanced Radiation and Plasma Oscillations

The sun has been known to emit radio-frequency radiation which maintains a high but variable level for periods of hours or days. This enhanced radiation proceeds from the direction of sunspots and shows circular polarization. With a view to explaining its nature, Dr. Hari K. Sen, of the Central Radio Propagation Laboratory, National Bureau of Standards, has considered the effects of plasma oscillations in a system of electrons gyrating around a static magnetic field. He has developed a theory originally conceived by the Swedish physicist K. G. Malmfors, who had obtained unstable oscillations and suggested their application to solar radio noise.

The term *plasma* describes a volume of ionized gas containing equal numbers of positively and negatively charged particles. Thus, a mass of hydrogen, the most abundant component of solar prominences, might be so heated as to have practically all of its atoms separated into their component negative electrons and positive protons. As a whole, the plasma would be electrically neutral, but the electrified components would be affected independently by such influences as electric and magnetic fields.

Wherever a prominence might move with high velocity in the magnetic field

of a sunspot, especially in the highly conductive regions of the sun's corona, if any motion were oblique to the lines of force the free electrons would be set to describing circular spirals. They, in turn, would generate electric fields, and the interplay of these forces might produce oscillations of the right frequencies to emit radio energy.

Ordinary collisions between particles in the prominence gases cannot explain the observed radio effects. It appears that any distortion of the distribution of the electrons will be repeated with the gyro-period of the electrons. The space-charge electric field will vary with the same period, achieving an effect similar to that in a cyclotron. The energy would be built up or amplified to an extraordinary degree. From such a mechanism, the energy emission would be circularly or elliptically polarized, agreeing with the observed polarization of the noise storms.

A numerical application to sunspot magnetic fields (of the order of 30 gauss) at coronal distances, about 100,000 kilometers above the photosphere, and to the density of solar prominence material indicates sufficient amplification over a wide frequency range covering that of 70 to 130 megacycles in which the Australians have obtained solar enhanced radiation. As the gyrating electrons have a peaked velocity distribution on account of the prominence motion, they do not suffer from the thermodynamic limitation set by the electron temperature. Further, the large frequency band-width over which amplification is available enables the radiation to escape through regions that are normally overdense for the gyro-frequency.

"Storm bursts" of radio energy from the sun that occur on an enhanced level have a narrow band-width, about four megacycles, and seem to owe their origin to a different mechanism that is probably localized in the solar atmosphere, for instance, shock waves produced by solar corpuscles moving with supersonic velocity.

### RR Lyrae Line Profiles

On the theory that Cepheid variables are pulsating stars, Shapley and Nicholson have predicted that the profiles of the spectral lines of these stars should be distorted. Dr. Malcolm P. Savedoff, Mount Wilson and Palomar Observatories, has studied the well-known star RR Lyrae, particularly favorable because it shows a measured velocity range of 60 kilometers per second. He and Dr. R. Sanford have obtained spectra with the 32-inch coude spectrograph of the 100-inch reflector.

For the spectral range 3960 to 4860 angstroms, only four lines were unaffected by blending and in other ways suitable for this exacting study. The

asymmetry of the lines was found, as predicted by the theory, and the results indicate directly for the first time the validity of the pulsation hypothesis.

### Orientation of Spirals

Two new criteria to determine which edge of a spiral galaxy is nearer us have been developed by Dr. John B. Irwin, of Indiana University, by a study of extremely short exposures that show only the brightest central portions of these objects.

Suitable photographs with the 36-inch Goethe Link Observatory reflector have made it possible to locate the position of the centers of approximately 40 spiral galaxies with nearly astrometric accuracy. When these positions were transferred to plates of 20 minutes exposure that showed outer portions of the nucleus of each galaxy as well as its spiral arms, Dr. Irwin found that, for 16 spirals, the position of the central point is asymmetrically located with respect to the brighter regions of the nucleus. These 16 objects are NGC 1068, 2683, 3169, 3190, 3623, 4216, 4258, 4527, 4826, 5005, 7331, 3627, 4565, 4594, 5033, and 5746.

Another feature is also evident in all 16 cases. One edge of the nucleus is always sharper or less diffuse than the other edge. Four of the 16 spirals (NGC 3190, 4565, 4594, and 5746) are so nearly edgewise that there is no question as to which is the nearer side, but, whether these four are used as con-

trols or not, the evidence fits the very reasonable assumption that each nucleus is partially obscured by heavy, sharp-edged absorbing material associated with the spiral arms in, or very close to, the central plane.

In 1943, Dr. E. P. Hubble, of Mount Wilson and Palomar Observatories, described the two original criteria for determining the tilt of a galaxy. The absorbing matter in the spiral arms on the near side could be seen projected against the nucleus, and the absorbing material could be detected much better on the near side. Thus, Dr. Irwin has doubled the number of criteria for finding the near side of a spiral galaxy. There are now a total of 18 spirals for which all the necessary data are known to apply the four criteria of tilt. These include the first 11 of the 16 galaxies already listed, plus NGC 224, 2613, 2841, 3031, 4088, 5055, and 6503.

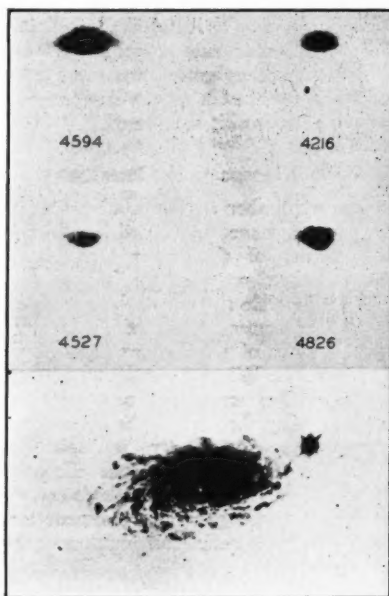
Dr. Irwin's results provide further confirmation of the belief that galaxies rotate in such a way that the spiral arms trail (*Sky and Telescope*, September, 1950, page 264). There is no doubt of the fact in these 18 cases.

### Asteroid Collisions

From Poland has been received a study of the chances of encounters among the asteroids, by Dr. Stefan L. Piotrowski, Krakow Observatory. He points out that it is not a simple matter to evaluate the physical effects of a collision, as it is very difficult to perform the appropriate experiments under laboratory conditions. He has had to base his reasoning on the rather scanty data of experiments with crater-forming by particles striking terrestrial rocks with impact velocities up to 20,000 feet per second.

Tentatively, Dr. Piotrowski finds that for the present structure of the asteroid belt the time interval of a billion years is significant—within this time the average minor planet can expect to undergo a catastrophic collision. If its orbit is highly eccentric or highly inclined, however, a few hundreds of millions of years become significant. These time intervals are only about a third as long if all less damaging encounters are considered. In other words, the time interval during which half of the mass of an asteroid may be crushed in non-catastrophic collisions is three times shorter than it is for collisions in which the asteroid is totally destroyed.

Adopting five kilometers per second as the mean relative collision velocity, Dr. Piotrowski computes that several millions of tons of matter are pulverized annually in the asteroid belt. This is large enough to replenish the dust of the zodiacal light, were we to assume that it is formed of asteroidal material rather than from the debris of comets, as has been proposed by Whipple.



These are negative prints, marked by John B. Irwin to show the actual center for M63, NGC 5055 (below), and for four galaxies for which short exposures show only the bright central nucleus in each case. Note that the sharp edge of each nucleus is on its near side.

## Photoelectric Photometry at Case

Another observatory has joined those that carry on photoelectric photometry. New equipment at the Warner and Swasey Observatory, Case Institute of Technology, was described by Donald A. MacRae, D. L. Harris, and J. B. Rogerson. The photometer, basically of the Kron design, can be used with both the 24-inch Schmidt and the 10-inch refractor of the observatory.

The Cleveland atmosphere was found not to be a serious detriment. Magnitudes and colors down to magnitude 12.3 can be observed with an unrefrigerated cell; this is the magnitude limit of the Schmidt when it is used with blue-sensitive plates and the four-degree objective prism. From one observation on one night, the color and magnitude of an individual star can be determined with a probable error of  $\pm 0.016$  and  $\pm 0.032$  magnitude, respectively, Dr. MacRae stated in presenting this paper.

Other Case astronomers at this meeting described how the colors of stars, obtained during seven months of operation with this equipment, were used to determine the interstellar absorption in two Milky Way regions.

## Trigonometric Parallaxes

Fundamental to all knowledge of the stars are the distances measured by triangulation to the nearest stars, the trigonometric parallaxes. On the recommendation of Commission 24 of the International Astronomical Union, the Yale University Observatory began late in 1948 the compilation of a new general catalogue of parallaxes. After careful consideration in consultation with parallax experts, Miss Louise F. Jenkins, in charge of the work, decided to limit the new (third) edition to modern trigonometric parallaxes only. Now ready for the printer, the catalogue contains trigonometric distances for 5,830 stars, compared with 3,930 in the second edition.

## Carbon Monoxide

The gas known as carbon monoxide has been identified on the sun, by University of Michigan astronomers, using an infrared spectrometer attached to the Snow telescope on Mount Wilson. The CO absorption lines have been detected in the infrared, in the region approximately from 23,100 to 23,300 angstroms. The absorption is stronger toward the edge of the sun than in the center of its apparent disk, indicating that the CO is present relatively high in the sun's atmosphere, where the temperature is about 5,000° absolute.

Carbon monoxide has been expected to be one of the most abundant molecules in the sun's atmosphere, but its absorption lines have been hitherto undetectable. Among other molecules already known in the sun, but much less

abundant than CO, are CN, CH, C<sub>2</sub>, NH, and OH.

In their report, Drs. Leo Goldberg, R. R. McMath, O. C. Mohler, and A. K. Pierce called attention to the strange distribution of carbon monoxide in the earth's atmosphere. This gas has been detected in the air over the Jungfrauoch in Switzerland, over Columbus, Ohio, but not over Flagstaff, Ariz. The Michigan astronomers find it absent over both Mount Wilson (where it might have been expected to be associated with the Los Angeles industrial smog) and the McMath-Hulbert Observatory at Lake Angelus, Mich. These observations indicate that carbon monoxide is localized in the atmosphere in a peculiar fashion.

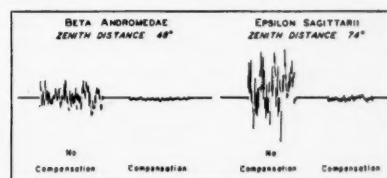
## Compensation for Seeing

Seeing noise, or stellar scintillation caused by movements of the atmosphere, has in the past restricted the accuracy of measures of star brightnesses, whether by visual, photographic, or photoelectric means. A new method of compensation for seeing, applicable to polarization photometry with photoelectric cells, has been developed by Dr. W. A. Hiltner, of Yerkes and McDonald Observatories. His instrument permits observational accuracy limited by the shot-noise of the photocurrent of the photocell.

Instead of measuring the polarized components of a star's light one at a time, Dr. Hiltner measures their ratio or difference by comparing the output of two photocells, one receiving the com-

ponent vibrating in one plane of polarization, the other receiving the component at right angles to the first. Color filters are used to restrict the spectral region observed in order to eliminate any noncoherency of the two beams resulting from different spectral responses of the photocells.

Thus, when atmospheric scintillation causes a star to brighten temporarily, both components of polarized light are increased, but their difference remains the same. In general, the signal-to-noise ratio may be taken as of the order of 100 to 1 under average seeing conditions, restricting the accuracy of magnitude measurements by other methods to  $\pm 0.003$  magnitude for a time interval of four minutes. From a series of 24 observations of Mu Herculis (a nearby star for which the polarization is assumed to be zero), each with a duration of four minutes, the probable error of a single observation by Dr. Hiltner's method was  $\pm 0.00016$  magnitude.



Seeing noise is ordinarily greater at larger zenith distances, as shown by the tracings above. Dr. Hiltner's method of compensation, however, practically eliminates the effect of seeing in these two cases.

## POPULAR ASTRONOMY CEASES PUBLICATION

POPULAR ASTRONOMY, for more than half a century an astronomical periodical of great importance and interest to professional and amateur alike, has ceased publication. In the December, 1951, issue (Volume LIX, No. 10), President Laurence M. Gould has expressed his regret that Carleton College is no longer able to support the journal, but he stated that arrangements were under way whereby publication might continue with another institution of learning.

Although strenuous efforts were made by a number of interested persons and institutions, plans to transfer the publication of *Popular Astronomy* into other hands have failed. Current manufacturing and production costs are so high that substantial financial support would be necessary.

By an agreement between Carleton College and Sky Publishing Corporation, to take effect only if plans to continue *Popular Astronomy* did not materialize, those readers of *Popular Astronomy* who are not already *Sky and Telescope* subscribers are receiving this magazine, issue for issue, in fulfillment of their original subscriptions.

Although it will not be possible, again because of high costs, to expand or alter the character of our magazine to fill the needs served so long by the senior journal, we do hope to include certain features of *Popular Astronomy* in our pages from time to time.

Professor William W. Payne, director of the Goodsell Observatory at Carleton College, founded the *Sidereal Messenger* in March, 1882. After 10 years, it was succeeded by *Astronomy and Astro-physics* (which a few years later became the *Astrophysical Journal*), and by *Popular Astronomy*, which Professor Payne continued to edit. Professor Herbert C. Wilson was the second editor. He was succeeded in 1926 by Dr. Curvin H. Gingrich, who died in June, 1951, after having been associated with the magazine since 1910. It was his loss that led to the circumstances requiring the suspension of publication.

Numerous expressions of hope for the continuation of *Popular Astronomy* have been received. These make deeper the regret with which we signal the close of nearly 70 years of continued literary efforts that have meant so much to the science of astronomy. C.A.F.

# An Experiment Concerning Pluto's Diameter

AT THE Los Angeles meeting of the Astronomical Society of the Pacific in June, 1951, a paper on the diameter of Pluto was presented by Dr. Dinsmore Alter, George W. Bunton, and Paul E. Roques, of the Griffith Observatory. They recalled a suggestion made years ago by Jeans, to the effect that the apparent small diameter of Pluto might be due to specular reflection from its surface, and they described their own experiments with four steel balls of different reflectivities.

Picture A of the accompanying photographs of these balls, each a little over an inch in diameter, shows them under general illumination. The ball to the lower right is in its original condition; that in the lower left was painted a mat white; the upper left one was covered with aluminum paint, and that on

the upper right was mottled with gray, mat white, and aluminum spots.

In the experiment, the balls were illuminated by a partially collimated beam from an electric lamp. Photographs B and C were taken with an ordinary view camera, with identical conditions and exposures, except that for B a sheet of white cardboard was held behind the balls. For D, the balls were taken at night to a point several hundred yards north of the Griffith Observatory, illuminated the same way as in C, and photographed with the 12-inch refracting telescope. Their angular diameters as seen from the telescope were about 25 seconds of arc.

For Pluto, Dr. G. P. Kuiper, of Yerkes and McDonald Observatories, has found an apparent diameter of 0.22 second (see *Sky and Telescope* for Oc-

tober, 1950, page 290), using a disk meter on the 200-inch telescope on Palomar Mountain. At Pluto's distance, this measurement indicates a linear diameter for that planet of only about 3,550 miles. Its mass, however, from its gravitational effect on other planets, is believed to be about equal to the earth's. The small apparent size and large mass are only consistent with an average density about 55 times that of water, many times greater than that of any other planet or of any chemical element in its normal state.

Visual observations made through the telescope under the conditions of photograph D gave the same impressions: The shiny steel ball appeared smallest, with the aluminum one somewhat larger. The ball painted mat white appeared largest, while the mottled one had a hazy outline. The experimenters concluded that "it is more reasonable to believe that the reflection from Pluto is partly specular than it is to accept either a very small mass or an extremely high density. If this be true, measures would reveal merely a minimum diameter of the planet. The actual diameter would be greater by an unknown amount."

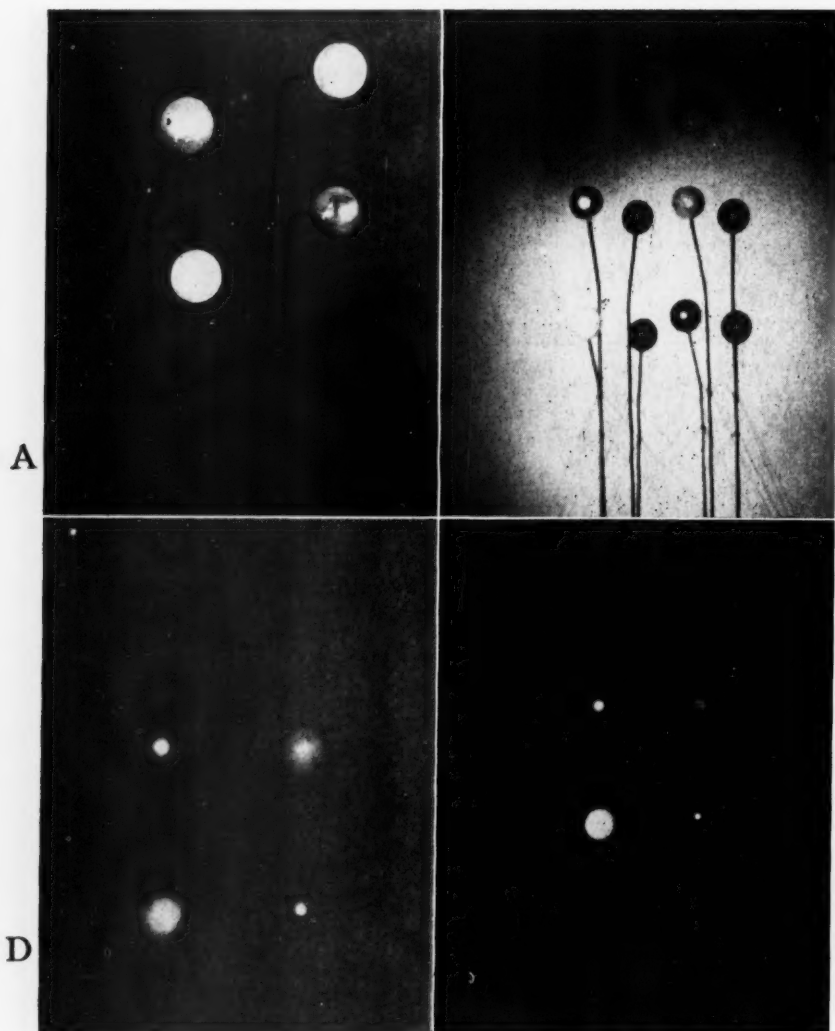
They suggest that because of the very low temperature which must exist on Pluto an atmosphere is impossible unless it is composed of hydrogen, helium, or neon. Without an atmosphere, the planet might have a relatively smooth frozen surface, which would reflect sunlight in specular fashion.

In the January, 1952, issue of the *Griffith Observer*, Dr. Alter, director of the Griffith Observatory and Planetarium, gives a complete account of Pluto's interesting history, beginning with the discovery of Uranus by Herschel in 1781.

## BRUCE GOLD MEDAL

The Astronomical Society of the Pacific announced on January 9, 1952, at its annual meeting, that the Bruce gold medal for 1952 has been awarded to Dr. S. Chandrasekhar, of the Yerkes Observatory, University of Chicago.

Dr. Chandrasekhar is best known for his theoretical research in the fields of stellar spectra, stellar motions, and stellar atmospheres. He was born in Lahore, India, and had his undergraduate training at the University of Madras. After several years of study and research at the University of Cambridge, he came to the United States in 1937 and has been a member of the faculty of the University of Chicago since that time. He is a distinguished service professor of theoretical astrophysics.



Steel balls with different surfaces were photographed under varying conditions. Engraving, courtesy "The Griffith Observer," published by the Griffith Observatory and Planetarium.

# BOOKS AND THE SKY

## OBSERVING THE HEAVENS

Peter Hood. Oxford University Press, New York, 1951. 64 pages. \$1.75.

"AS THE TWIG is bent so grows the tree," is still a good adage, and we should keep aware of the influence people and ideas have on young folks. With social agencies turning toward child uplift, juniors are getting the type of attention and direction that is much needed. The Astronomical League goes along with the child-direction idea in promoting junior activity as an aid to science-minded youngsters. Ideas that are applicable and that have been found to work are gladly welcomed.

Astronomy fits in between police-club physical activity and the plodding chores served by educators. Star watching is a universal pastime that costs little, except in time. We understand that everybody can't be interested in astronomy, but we can make a lot of smoke and hope for some fire.

In these days of picture magazines and tabloid papers, reading consists largely of picture captions. This gulping consumption of information leads the young folks to television glimpses of science. The problem of creating interest is superseded by the insistent demand for interest holding. Astronomy is no stranger to this problem. A story in a newspaper or a visit to one of the many planetariums opens the door to the enjoyment of the oldest of the sciences. How to keep this interest is the next big order.

Peter Hood has done a commendable job with his **Observing the Heavens**, a book which is light in weight but concise and loaded with facts. Thirty-two chapters are condensed into 64 pages, and the whole field of astronomy is covered for young people. The book creates interest, answers the common questions, and pictorially shows the material that everybody should know.

The largest section is devoted to constellation observing, and the accompanying star maps are designed for year-round stargazing. With only four magnitudes shown, the city dweller can more easily trace out the star groups. The brighter clusters and nebulae are indicated as an incentive for those possessing optical aid.

The greatest igniter of astronomical interest is the telescope. Peter Hood makes the good suggestion that one should approach any neighboring amateur who is known to possess a telescope and get a few choice views through the instrument. Telescope construction is covered in two pages! The suggestions in this section may not be sufficiently complete to permit everyone to produce a usable instrument, but it does bring the mysteries of the optic tube into the open. It certainly leaves one with the impression that a home-built telescope is possible; that is important. Many famous astronomers and opticians started with the crudest paper, glue, and eyeglass instrument. Remember that Galileo shattered a pyramid of philosophy with a relatively crude instrument.

A catalogue of planet positions for a decade is given. Eclipse dates and op-

positions of Mars add almanac material. The bibliography that takes up the space where we usually find the index is more like a reading list for adults than for youngsters.

The question of who are young people may arise for some readers. The standards of school level of the other hemisphere are much higher than in our popular education. The English schoolboy is more like our junior college student. Thus, this book could easily serve as an introduction to astronomy for all beginners.

EDWIN F. BAILEY  
Middle East Regional Chairman  
Astronomical League

## CATALOGUE OF PHOTOGRAPHS AND SLIDES

From the Mount Wilson and Palomar Observatories. California Institute of Technology Bookstore, 1201 E. California St., Pasadena 4, Calif., 1951. 15 pages. Available on request.

LONG AWAITED is this new catalogue of Mount Wilson and Palomar photographs, transparencies and slides, for it contains 46 photographs taken with the 200-inch telescope and eight made with the 48-inch Schmidt. These are all illustrated among the 156 miniature halftones that show the subjects available in the catalogue as a whole (except the spectra).

The 60-inch and 100-inch instruments, however, are not to be belittled, for they furnish between them 27 pictures in the section on nebulae and clusters, and the majority of the photographs of the moon, planets, and comets. Some miscellaneous photographs, solar phenomena, spectra, instruments and buildings at the two mountain observatories, are the other sections of the catalogue.

The section on spectra has been improved and brought up to date. Included are 15 high-dispersion stellar spectra, generally of one angstrom per millimeter dispersion; such representative stars as Sirius, Arcturus, and Beta Pegasi are included. Infrared spectra of the sun, with wave-length scales, are available from 6600 to 12,600 angstroms. There is a picture of the principal types of stellar spectra, O, B, A, F, G, K, M, N, and S.

All orders are to be sent to the California Institute of Technology bookstore, at the address given above. Photographs 8 x 10 inches are 75 cents each; 16 x 20 inches, \$5.00. Transparencies 8 x 10 inches are \$3.50 on glass, \$3.00 on film, \$3.50 on Adlux film (transfusion base); 16 x 20 inches, Adlux film, \$11.00. Standard lantern slides, 4 x 3 1/4 inches, are \$1.50. To each order 75 cents should be added for postage and packing.

Many of the photographs in the catalogue may be purchased from England. European orders should be addressed to The Assistant Secretary, Royal Astronomical Society, Burlington House, London, W.1, England.

Included in the catalogue are descriptions of a postcard set, 14 cards for \$1.00 postpaid; **Frontiers in Space**, official publication of the observatories, 65 cents

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C. A. F.

## THE AURORAE

L. Harang. John Wiley and Sons, Inc., New York, 1951. 166 pages. \$4.50.

THIS is the first volume of the International Astrophysics Series, which is to provide authoritative material suitable for both specialists and students dealing with the main branches of astrophysics and radio astronomy.

The *Aurorae* exemplifies the spirit of the series in presenting a compilation of the facts concerning the appearance of the auroral phenomena, as well as giving methods for height determinations and including information on certain phases of the subject for which the original publications are not readily available.

The first chapter contains a description of auroral forms, illustrations and methods of parallactic photography, and a discussion of the methods of reduction of aurora photographs for the computation of heights together with the construction and application of observing nets for determining the positions of auroral forms.

Subsequent chapters deal with the position in space of the aurorae, the spectrum and other light effects from the auroral region, terrestrial magnetic storms and the aurorae, the corpuscular theory of the aurorae, the ionosphere, and earth-magnetic perturbations. There is an extensive bibliography.

The book is profusely illustrated with photographs and diagrams, including many which have appeared previously in various publications, but they are necessary to present adequately the contributions to auroral theory by some leading authorities in the field. The lay reader may wish that the author had included more description of some of the illustrations, and may have some difficulty in following the mathematical development of the corpuscular theory of the aurorae.

Researchers in geophysics have suggested that the upper atmospheric layers contract after sunset. Vegard has shown that the heights of arcs, bands, draperies, and rays decrease during the night, and if one assumes that the mean penetrating power of the corpuscles producing the aurorae is the same during the night, the decrease in heights of the lower border indicates that the isobaric level, where the particles are stopped, has been lowered during the night.

### INDEXES AND BACK ISSUES

of *Sky and Telescope* are available. For Volumes I through IX, the index is 35 cents postpaid; it is included without charge in the October, 1951, issue for Volume X. For back issues, let us know your needs and we shall try to fill them.

SKY PUBLISHING CORPORATION

Observations up to now indicate that the intensity of the faint hydrogen lines is quite variable, and Vegard has expressed the opinion that the hydrogen lines are due to showers of hydrogen occasionally entering the atmosphere together with electrically charged particles during auroral displays. The auroral spectrum is emitted in a region where the density and pressure are not accurately known. The relative abundances of nitrogen, oxygen, both atomic and molecular, and of ozone, are unknown. The velocity and nature of the electrically charged particles entering the atmosphere to cause the aurora are therefore not definitely known, but the recent work of Gartlein and Meinel, not covered in this book, may help develop the theory.

During strong earth-magnetic storms, often accompanied by bright aurorae in the zenith, there is a complete cessation of radio echoes from the ionosphere. During the very greatest storms the echoes may disappear on all frequencies for more than 24 hours. This storm effect must be regarded as a result of increased absorption below the E layer, apparently restricted to the height interval where the lower borders of the very strong auroral displays appear (80 to 90 kilometers).

The author is chief scientist for the Norwegian defense research establishment, and is well known for his researches on aurorae. The book naturally emphasizes the work of his country's auroral students, led by Carl Stoermer.

D. S. KIMBALL  
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## NEW BOOKS RECEIVED

**STARS**, Zim and Baker, 1951, Simon and Schuster. 157 pages. \$1.00.

With copious diagrams and pictures, and effective use of color throughout, this book makes a valuable addition to the Golden Nature guide series, which now includes *Birds*, *Flowers*, *Insects*, and *Stars*.

**L'ESPRIT DE L'HOMME A LA CONQUETE DE L'UNIVERS**, Gerard de Vaucouleurs, 1951, Editions Spes, 79 Rue de Gentilly, Paris XIIIe. 252 pages, paper bound. 500 fr.

This is the first volume in a French collection to be entitled, "L'Homme dans l'Univers." This book, subtitled "L'Astronomie des Pyramides au Mont Palomar," outlines essential astronomical discoveries chronologically, and emphasizes also the techniques of astronomical progress and the philosophical and scientific consequences of the discoveries.

**THE PRINCIPLE OF RELATIVITY**, various authors, 1952, Dover. 216 pages. \$1.50 paper, \$3.50 cloth.

A collection of original memoirs on the special and general theory of relativity, by H. A. Lorentz, A. Einstein, H. Minkowski, and H. Weyl, first published in English translation in 1923, and reissued now in a paper-bound edition.

**ECLIPSES OF THE SUN**, S. A. Mitchell, 5th edition, 1951, Columbia University Press. 445 pages. \$6.50.

The text of this standard work, which first appeared in 1923 and has not had an edition since 1935, has been completely revised, with inclusion of new problems "from the point of view of the latest information regarding the structure of the atom."

**GENERAL EDUCATION IN SCIENCE**, Cohen and Watson, editors, 1952, Harvard University Press. 217 pages. \$4.00.

General education goals and teaching methods used in the scientific field are discussed by a group of specialists, analyzing the place of science in the collegiate education of nonscientists, the layman's difficulties in understanding science and scientific methods, and the emphasis and techniques in teaching general education science courses at Harvard and elsewhere.

**THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC**, 1953, Nautical Almanac Office, U. S. Naval Observatory, 1951, U. S. Government Printing Office. 642 pages. \$3.75.

The *American Ephemeris* for the year 1953 is available from the Superintendent of Documents, Washington 25, D.C. Its principal parts are: I, Sun, Moon, Planets; II, Stars; III, Eclipses and Occultations; IV, Physical Ephemerides; V, Satellites; VI, Miscellaneous Tables.

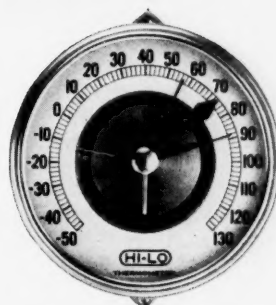
**A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY—THE CLASSICAL THEORIES**, Sir Edmund Whittaker, 1951, Philosophical Library. 434 pages. \$12.00.

This book, noted in the November, 1951, issue of *Sky and Telescope*, and reviewed in this department in January, 1952, is now available in this country through the Philosophical Library, Inc., New York.

**LIGHTNING AND THUNDER**, Herbert S. Zim, 1952, Morrow. 64 pages. \$2.00.

Plentifully illustrated with pencil sketches and diagrams, this Morrow junior book discusses the whys and wherefores of thunderstorms, and includes a number of simple experiments in electricity that children can perform.

## HI-LO THERMOMETER



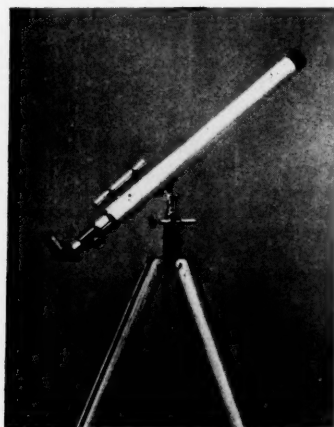
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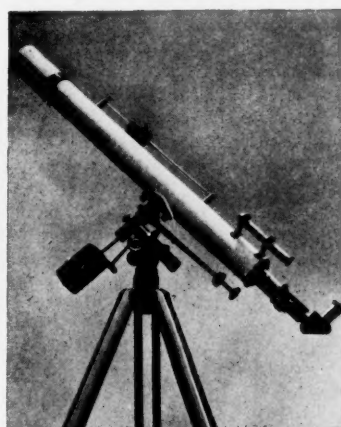
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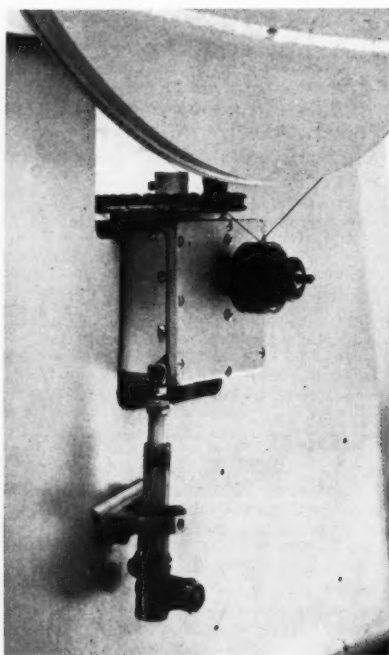
EDITED BY EARLE B. BROWN

## A STURDY MOUNT AND A SANDBLASTED MIRROR

FROM Phoenix, Ariz., comes the photograph on this month's front cover of a new 16-inch combination f/18 Gregorian and f/3.3 Newtonian telescope. Although the instrument and its cover weigh about 2,200 pounds, they may be transported from place to place on a trailer with heavy wheels. After the telescope is set up on three steel pillars, four bolts may be removed and the axle and wheels rolled away.

The builder, Dr. William A. Rhodes, president of the Phoenix Observatory Association at Phoenix College, includes in the following description the method of sandblasting the curve on the mirror and the hole through the mirror's center. His use of lead-filled magnets for counterweights and of Selsyn control on secondary-mirror focusing are interesting innovations. He writes:

**Construction and controls.** The instrument is entirely of boxed steel, including the fork. The entire overhang weight on this shaft is about 450 pounds, but the shaft size would allow a total of 1,600 pounds within the permissible deflection. Small radio speaker magnets filled with lead are used for counterweights. They fasten themselves permanently anywhere they make contact, thus eliminating the unsightly weights of more conventional scopes. Some of the magnets can be seen clustered about the eyepiece, and about 40 more are placed where needed inside the fork and elsewhere.



The steel-wire driving mechanism of the Rhodes telescope. The tape that forms the right-ascension circle is not in place.

The right-ascension disk at the base of the fork has a flat groove machined to an exact circumference of 72 inches. An ordinary flexible steel measuring tape is placed in the groove and the ends are fastened together with a spring, to form the right-ascension circle. The tape can be set at any point the operator wishes.

The clock is a synchronous motor driving a gear train which finally leads up to the box projecting through the face plate. This box houses two precision worms. The black pulley projecting from the box is friction-coupled to the shaft, and has three grooves: one slower than sidereal rate, the next exactly sidereal, and the third fast. The grooves in the driving pulley are machined to a V with a fine point at the bottom so that the small steel driving wire will firmly grip the sides after tension is applied. The tension jack may be seen on the face plate just below the gear box. The steel wire connects the pulley to the large circle, at the top of which the ends of the steel wire belt are brought through an angular hole in the groove and secured with a bolt in the plate. With a power of 400, the backlash is about half the diameter of an out-of-focus star disk. With a Variac (variable AC transformer) on the motor and the telescope set on the fast or large drive pulley, the instrument can be guided with extreme smoothness.

All bearings are of the self-aligning type, designed to take radial as well as thrust loads. The heavy grease in which they are usually packed has been replaced by a very light rust-preventing oil (Fiend oil). The friction is so small that half an ounce of pressure on the fork will roll the instrument over when it is free. I can say here and now that I shall never again use ball bearings on a declination axis. They are undesirable and unnecessary in this particular application. I had to introduce a non-backlash friction brake inside the fork to stop the roll of the telescope in declination. The small black knob on the fork adjusts the pressure of the brake. Although there is no declination slow motion yet, it is possible to guide by hand, as a starting jerk is not detectable at 400 power. The smoothness of this action when properly adjusted has surprised me, as I have hitherto frowned on friction devices. Changing position is a simple matter of swinging the instrument by hand.

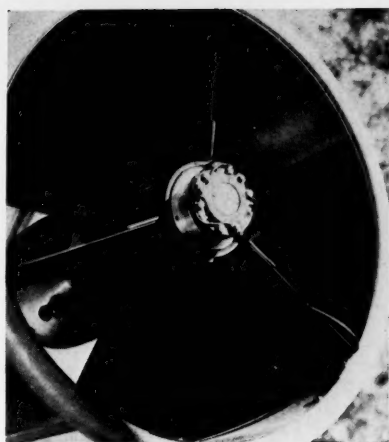
In the Gregorian arrangement, a pair of Selsyns focus the secondary. One is visible, in the secondary-support picture, at the center of the spider; the other is mounted on top of the mirror cell, as seen in the eyepiece picture. The secondary is mounted on a tube which slides in a self-zeroing "way," like that of a lathe, which is always in line no matter where it is along the axis. Even though there is a rack and pinion at the eyepiece, the Selsyn is far superior for adjusting focus. One only needs to move the secondary a fraction of an inch by Selsyn to set the focus for a different eyepiece. A floating

nut within the sliding part of the secondary is coupled to a finely threaded shaft on the Selsyn. This removes any tendency toward forcing the secondary out of line sideways, although it drives positively along the optical axis. The temperature rise in about an hour in the Selsyn is about two degrees above the surrounding temperature, so a switch has been provided to cut off the current in the Selsyns when they are not being used.

The wooden dowel attached to the spider in the picture was merely used for mechanical alignment at the time of construction. Not shown in the pictures is the Newtonian diagonal for low-power wide-field use, or a K21 Ektar f/2.5 camera which will be installed later.

The black box on the right center of the tube is the finder, a projection sight used on aircraft guns. This has a dot of light in the center of two rings. When the dot is centered upon the object, the latter should appear in the center of the telescope field. For instant sighting this system offers an advantage, as it apparently places the rings and dot out among the stars.

The eyepiece rack and pinion is on a plate which can be replaced with a cut-film holder and shutter. The stainless steel dew cap around the mirror cell is removable for adjustments. As the mirror itself is figured on the small side, the mold taper of the glass is used to advantage. Four screws (two are visible in the eyepiece photo) are run in against laminated leather pillows bearing on this taper and then backed off a tiny bit. The mirror back rests on three similar screws

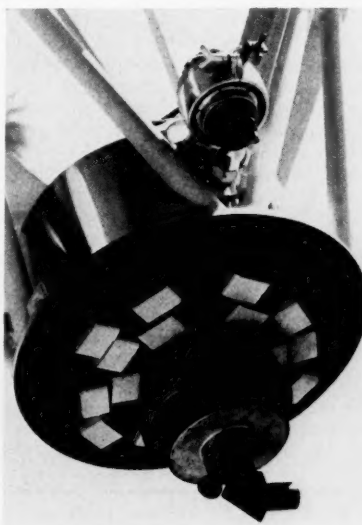


The top of the tube of the telescope, showing the Selsyn drive by which the secondary is focused.

with pads. I turned these down very tight with the side screws tightly in place and tried to force a bend in the mirror figure under the Foucault test, but noticed none. These tests were made upon star images at focus without the eyepiece and also with a pinhole, using both Newtonian and Gregorian arrangements.

**Sandblasting.** The f/3.3 curve, with a sagitta of 0.290 inch, was roughed out on the 16-inch blank with a cemetery monument sandblast gun. This was completed in about 30 minutes, saving about 40 hours of rough grinding. A template for the curve was inscribed on a piece of cardboard using as a compass a wire equal to the radius of curvature, fixed at one end, and with a pencil at the other.

There are no tricks to sandblasting a curve on a mirror blank. Start with low pressure (about 45 pounds), and after you get the feel of it, the pressure can be increased to 100 pounds or more. Use any



The eyepiece portion of the Rhodes instrument, showing many of the magnetic counterweights in place.

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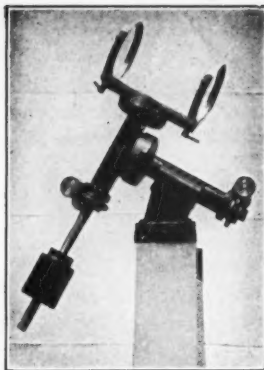
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size grit up to about 20 mesh. The finer the grit, the longer it will take. Here are a few pointers: 1. Keep the gun on the move in a crazy-quilt pattern, never allowing the gun to come to a standstill for very long on any one point. 2. Keep away from the extreme edge with the blast as the edge will get its share from side particles. 3. Tape a strip ¼ to ½ inch wide around the edge with the rubber or paper tape sandblast companies keep on hand. 4. Check at least every two minutes, using the template directly against the face of the blank in various positions. Take along a black crayon so that near the end you can mark the high spots, and knock them off with a couple of sweeps of the gun. 5. Use the gun yourself. Most sandblast operators will never have seen a mirror blank; they are likely to give the edge too much, or to dig out a hole.

The control of sandblasting guns using either a broad spread or a narrow jet nozzle is easy to learn, and after about a minute of operation you will have complete confidence in your ability. There is no danger of fracturing the glass, but be sure the mirror is propped firmly against a rigid backing, as the "wind" from higher pressures of the gun is considerable. Any glass under 12 inches should be firmly tied down. Considerable caution is required when this method is used for focal lengths longer than f/8; the grit should be finer than usual, and frequent close checks on the curve depth made. On such shallow curves, the depth will be reached unexpectedly soon when heavy grit is used.

As for getting an approximately spherical surface, I would say that the curve will generally take care of itself if the gun is kept in motion at all times and kept well aligned with the central axis, held about two feet away from the blank. The numerous small humps on the surface will plane down with the first hour of hand roughing.

After we had finished all the figuring of the 16-inch mirror, its entire surface was masked with monument rubber, except for a central area of the proper size on the front and back, with double thickness of rubber around this area. Then the mirror was perforated with the sandblast gun, halfway through from each side. The heat of this process was carried away with the chips before it could penetrate to the rest of the blank. As before, in hole blasting the gun should be kept on the move or the sand will burn away the rubber masking and attack the polished surface. With this process, the central hole will be about one degree conical toward the center.

I have used this sandblast method on a 12-inch f/1 Schmidt, a 12-inch f/2.7 parabola, and on this 16-inch mirror.

**Mounting stability.** It is about a two-minute job to put the telescope into operation from the time the hood is rolled off until the object is in focus. A small pipe

is visible on the cover picture, near the declination axis on the under side of the fork. During travel this rests on a long vertical pipe, which in turn sets on the H-beam below. Two pipes hold the fork horizontal and take the load off the main shaft. A nut on the center top of the fork freezes the instrument itself.

To remove the rollaway cover of aluminum and steel is a one-man job. It is in automatic alignment when on the ground, and slides home on rollers under the rails of the telescope floor. When the axle and wheels are rolled away, there is nothing to indicate that the telescope was ever on wheels.

The mount is made of heavy 6" structural H-beams, and sets on three steel pillars on top of the ground. One night a friend happened by. The scope was on Saturn, and he asked me to jump on the ground. When I did so, he showed surprise and asked me to look while he jumped. Under a power of 400, the vibration moved the image about a third of its diameter and then back to zero. To test this further we obtained a 300-pound iron ball and set up a rig for hoisting it. We dropped the ball about two feet from the front pillar—the planet moved one diameter and back again.

Later we placed a length of 6" well casing five feet into the ground, tamping it down to the surface, and then we clamped the casing to the mounting with two massive steel clamps. This time when we jumped anywhere within a radius of 10 feet of the scope, the image jerked out of the field, but always returned to zero. Automobile traffic 150 feet away, which had never caused the slightest noticeable tremor before, now produced about half to one diameter deviation with the instrument tied to the casing. This proves one point to me: Where bedrock is not available, it is much better to set the instrument on top of the ground rather than tie it to the ground, where it is forced to move with the earth.

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# OBSERVER'S PAGE

Universal time is used unless otherwise noted.

## VISUAL OBSERVING PROGRAMS FOR AMATEURS — XXIV

### Eclipsing Variable Stars — (continued)

**Observing Algol.** The following method is only suitable for determining the time of minimum brightness of the variable star. It does not determine the light curve, and so is not of much value with other types of eclipsing binaries, where the shape of the light curve is fully as important as the exact time of minimum. If an observer is blessed with good weather, it is possible to obtain results with this visual method that agree within about a minute with those obtained photoelectrically.

Algol is of apparent visual magnitude 2.3 at maximum and 3.5 magnitude at minimum; it takes about 4½ hours to fade from maximum to minimum and a like time to rise again to maximum. However, it is not possible to go out and look at Algol and say, "As the star is now of magnitude 3.5, it must therefore be at minimum." Actually, there is a period of nearly an hour at minimum when one cannot reliably detect any changes in the star's brightness.

As with any phenomenon of a sine-like nature, Algol's light is changing fastest at the halfway point, that is, at about the time it is 2.9 magnitude, so observations at this time are inherently more distinctive than at any other time in its cycle. If we can determine the time at which Algol is 2.9 magnitude on the descent, and a few hours later the time when it is of this brightness on the ascent, we can take the midpoint of these as the time of minimum.

These descent and ascent observations do not have to be made on the same night, however, for Algol's period is very well known. Suppose we have a descent observation; then an ascent observation one or even as many as eight periods later can be transferred to the original night by subtracting one or as many as eight periods. Any difference in the equation of light must be applied also, although this is usually insignificant if both observations are made near the star's opposition to the sun, as described last month. The

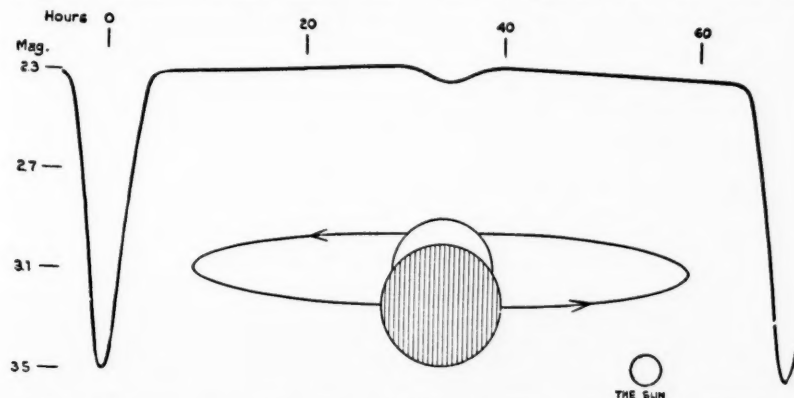
period of Algol is 2.86731525 days, according to Eggen. If we were sure that this never changes, there would be little need to observe Algol for a minimum epoch often than once a century, but the star's period does seem to change gradually with time.

More important than trying to observe both descent and ascent on the same night, to procure constant observing conditions, is to make the two observations with the star at approximately the same altitude above the horizon each time, and with the comparison stars in the same relative positions with regard to Algol and the horizon. The comparison stars are widely separated, because Algol is brighter than its near neighbors, and the atmospheric absorption will not be the same for all of them. Therefore, make the second observation when the stars are as nearly as possible in the same positions above the horizon as they were on the first occasion.

Furthermore, my eyes are not symmetrical when it comes to estimating stellar brightness, and others may have this same trouble. By this lack of symmetry I mean: Suppose two stars A and B rise in the east and to my eyes they seem exactly equal in brightness. Suppose A is nearer the north pole than B, and hence is to the left of B. But when they are setting in the west, A appears to the right of B, and to my eyes B seems brighter than A by about 0.2 magnitude. It took me many hours of observing Algol and plotting my results before I discovered this simple fact about the observing errors in my eyes.

Fortunately, it is possible to find pairs of dates at the first of which Algol will be decreasing in brightness and at the second increasing in brightness, and at each of which times it will be at substantially the same altitude above the northeastern horizon. October and November are the best months, but other seasons can be chosen if the equation of time is taken into account.

The comparison stars are Zeta (§)



The light curve of the Algol eclipsing binary system. The stars are shown in the orbital position corresponding to the deep or primary minimum; note the slight secondary minimum. From "Introduction to Astronomy," by Robert H. Baker, published by D. Van Nostrand Co., Inc.

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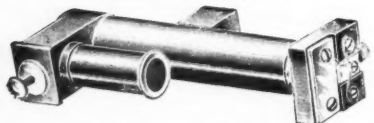
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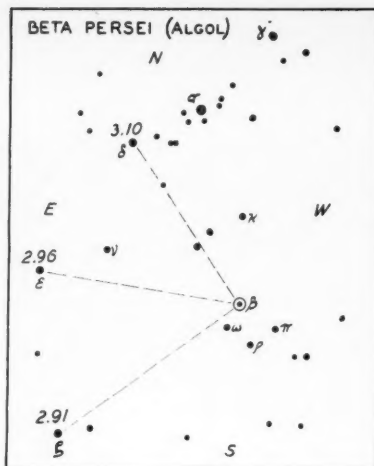
The dispersion is 34° and the slit is provided with an adjustment for varying the width. A graduated drum by which the spectrum can be moved across the field, used in conjunction with the built-in indicator, enables readings to be taken. This drum is divided into 100 divisions, which are arbitrary, but which can be calibrated if desired by the user. An adjustment for accurately focusing the spectrum is provided.

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The constellation of Perseus and the comparison stars for visual observations of Algol.

Persei, magnitude 2.91, and Epsilon (ε) Persei, magnitude 2.96, both B-type stars, as is Algol itself. Delta (δ) Persei, 3.10, may also be used, but I have preferred the first two. Although these stars are too far from Algol to be included with it in the field of binoculars, I do all the observing with low-power binoculars, in which I throw the stellar images considerably out of focus. The resulting disks can be gauged more exactly for equality of total light than the pinpoint of light presented to the naked eye by the stars themselves.

I do not attempt to estimate the time when Algol is 2.90 magnitude, nor indeed its brightness in magnitudes at all, but instead I record its brightness expressed in five steps, which are: above 2.91, equal to 2.91, between 2.91 and 2.96, equal to 2.96, and below 2.96. To my eyes the star does not descend these steps in an orderly fashion, but may hop up and down as, for instance: above 2.91, between 2.91 and 2.96, equal to 2.91, between 2.91 and 2.96, equal to 2.96, between 2.91 and 2.96, below 2.96. However, if these observations are plotted on a curve against time, it is possible to judge to within about a minute when Algol actually passed through the range between 2.91 and 2.96. Perhaps the best guides are the last observation when the star was definitely above 2.91 and the first observation in which it was definitely below 2.96. A sense of judgment is necessary in interpreting one's observations.

Similarly, on the ascent, the time when Algol passes through this brightness zone is determined. The midpoint of the two times gives the epoch of Algol's minimum, since it is known that Algol's light curve is symmetrical.

Of course, there is always the chance that the second of the two observing dates will be clouded out, in which case the first night's work will have limited value. Two equally skilled observers may not agree on the time that Algol passes through the critical zone of brightness—they may differ by as much as 10 minutes. But conversely, their estimates will disagree by the same but an opposite

amount when Algol is increasing in brightness. Hence, one observer's descent and ascent determinations may be matched against each other, but they cannot be combined with those of another observer.

When Algol is in the critical zone, I usually make observations at about two-minute intervals. This critical period usually lasts for about 20 or 30 minutes, so there is no use tiring one's eyes by trying to observe more frequently.

DAVID W. ROSEBRUGH

79 Waterville St.  
Waterbury 10, Conn.

ED. NOTE: The foregoing "exercise" is recommended as a project for a group observing program.

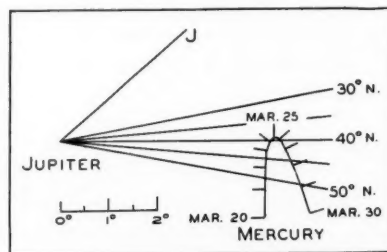
### A CLOSE APPROACH OF MERCURY AND JUPITER

**D**URING the favorable evening elongation of Mercury in March, an interesting configuration with Jupiter takes place. The date of closest approach is the 24th, when the two planets will set nearly simultaneously about an hour and 20 minutes after the sun.

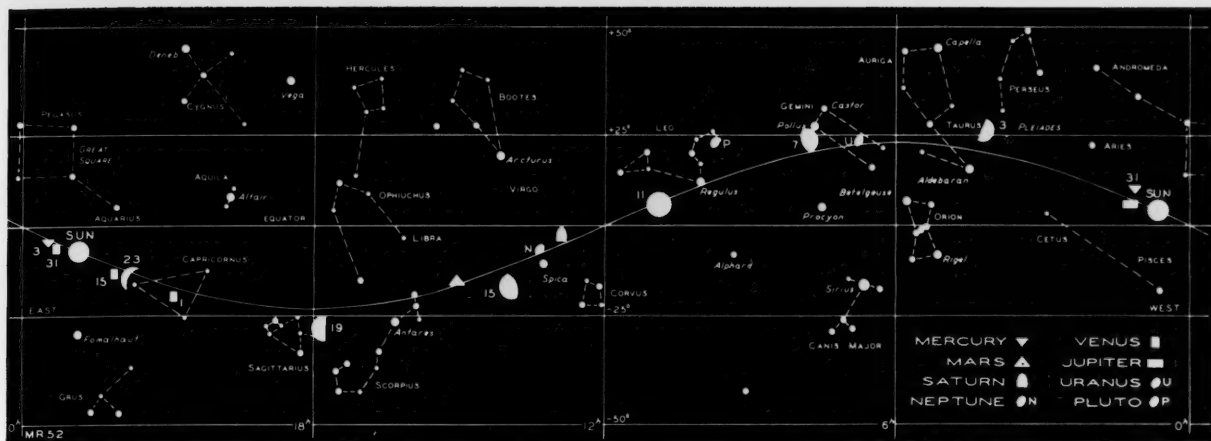
This will be a fine opportunity to compare the two planets telescopically, inasmuch as they will be at equal altitudes and similar azimuths. Mercury will subtend a diameter of about nine minutes of arc, while that of Jupiter will be 31 minutes. The latter is such a well-known object for even small telescopes that it will furnish an ideal comparison for testing observations of Mercury. Since this approach occurs nearly a week after the date of Mercury's greatest elongation east, the inferior planet will appear as a thick crescent.

The proximity of the two planets should make it easy for observers to pick out Mercury. Look for it below Jupiter as early as March 6th, on which date it sets about one hour after the sun but 1½ hours before Jupiter. The larger planet will still be very conspicuous at this time and the two will rival each other in brightness. When they draw closest together, however, the brightness of Mercury will have diminished considerably.

Although the Graphic Time Table of the Heavens (January issue, page 64) predicts that Mercury will never set later than Jupiter during this elongation, calculations from the data in the *American Ephemeris and Nautical Almanac* indicate that it will do so on the evening of March 24th. The accompanying diagram shows the azimuth



The line marked 40° N. represents the western horizon for that latitude. Mercury's setting positions are marked by dates along the curve. Diagram by Paul W. Stevens.



### THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

and altitude of Mercury relative to Jupiter at 0<sup>h</sup> UT, with the giant planet on the horizon, over a 10-day period. The computations were made for a latitude of 40° north, the one used in the Graphic Time Table, and the horizon for that latitude is drawn horizontal. Other lines emanating from the position of Jupiter indicate the approximate horizon for other latitudes.

The line marked J is the hour circle through Jupiter. It would be horizontal for a station on the terrestrial equator. If Mercury were to cross that line, two conjunctions in right ascension would take place. As it is, however, there will be no actual conjunction even though, in latitudes north of 40°, Mercury will set later than Jupiter for a number of days. It is the difference in declination of the two that brings about these circumstances.

Since the points marked on the curve are for 0<sup>h</sup> UT, or 7 p.m. EST, they correspond almost exactly to conditions along the Atlantic seaboard when the planets are setting on the previous day.

A close conjunction of the one-day-old moon with Mercury occurs on March 26th, the planet being 44' south geocentrically at 22:50. The moon, Jupiter, and Mercury will present a beautiful triangle within the field of view of binoculars. At Vancouver and Calgary (stations I and G), there will be a daylight occultation of Mercury, for which data is given on page 128.

PAUL W. STEVENS

### MOON PHASES AND DISTANCE

First quarter .....	March 3,	13:43
Full moon .....	March 11,	18:14
Last quarter .....	March 19,	2:40
New moon .....	March 25,	20:12
First quarter .....	April 2,	8:48

	March	Distance	Diameter
Apogee	6, 23 <sup>h</sup>	251,800 mi.	29' 29"
Perigee	22, 22 <sup>h</sup>	227,100 mi.	32' 42"
	April		
Apogee	3, 18 <sup>h</sup>	251,300 mi.	29' 33"

### UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

Mercury may be favorably observed in the evening sky except for the first and last few days of March. Greatest elongation takes place on the 18th, 18° 31' east of the sun, when Mercury sets 1½ hours after the sun and is of magnitude -0.1. Two weeks earlier, however, when it sets only an hour after the sun, Mercury is about 2½ times brighter.

Venus will be seen in the morning sky by casual observers for the last time this year during March. Poorly situated, Venus rises only three quarters of an hour before the sun by the end of the month, in latitude 40° north. It is of magnitude -3.3.

Earth arrives at heliocentric longitude 180° on March 20th at 16:14 Universal time. Spring commences in the Northern Hemisphere and autumn in southern latitudes, the sun crossing the equator northward.

Mars is rapidly attaining prominence as it approaches opposition on May 1st. Rising four hours after sunset on March 15th, the ruddy planet is located just to the east of Alpha Librae. Retrograde motion commences on March 25th, at which time the Martian disk will be 12".7 in diameter. During the month, Mars brightens from +0.1 to -0.7 magnitude, outshining all other objects in that region of the heavens.

Vesta comes to opposition March 1st at a distance of about 128 million miles from Earth, its apparent magnitude +6.5. It is in central Leo, on the path charted on page 72 of the January issue.

Jupiter, found low in the western sky at sunset during March, disappears into the sun's rays in early April. Its configurations with Mercury are described elsewhere in this department.

Saturn rises near the east point shortly after sunset; opposition to the sun occurs on April 1st. It is of magnitude +0.6, in retrograde motion in central Virgo. The ring system is a fine object for a telescope, large or small, being 43" in major diameter, inclined 8°.6 to our line of sight.

Uranus reaches eastern quadrature on March 30th, visible until well past mid-

night. Two degrees south of Epsilon Geminorum and of the 6th magnitude, the planet resumes eastward motion on the 18th.

Neptune, approaching opposition on April 10th, can be observed most of the night. It is approximately 4° north of Spica, and is in retrograde motion. It is of the 8th magnitude. On the 15th, its position is 13<sup>h</sup> 20<sup>m</sup>.3, -6° 38' (1952 coordinates).

E. O.

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## VARIABLE STAR MAXIMA

March 1, V Ophiuchi, 7.5, 162112; 2, R Canum Venaticorum, 7.7, 134440; 2, T Hydrae, 7.7, 085008; 6, V Coronae Borealis, 7.4, 154639; 16, U Orionis, 6.6, 054920a; 17, RR Sagittarii, 6.6, 194929; 20, R Centauri, 5.9, 140959; 25, R Pegasi, 7.9, 230110; 27, RV Sagittarii, 7.8, 182133; 31, T Centauri, 6.1, 133633.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

## MINIMA OF ALGOL

March 3, 5:12; 6, 2:01; 8, 22:51; 11, 19:40; 14, 16:29; 17, 13:18; 20, 10:08; 23, 6:57; 26, 3:46; 29, 0:35; 31, 21:35.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See *Sky and Telescope*, Vol. VII, page 260, August, 1948, for further explanation.

## PREDICTIONS OF BRIGHT ASTEROID POSITIONS

**Amphitrite**, 29, 9.4. March 9, 13:21.7 —11-03; 19, 13:14.8 —10-50; 29, 13:06.1 —10-24. April 8, 12:56.6 —9-50; 18, 12:47.4 —9-13; 28, 12:39.5 —8-37.

**Hebe**, 6, 9.6. March 19, 13:28.0 +9-25; 29, 13:20.4 +10-56. April 8, 13:12.0 +12-17; 18, 13:03.5 +13-19; 28, 12:55.9 +13-58. May 8, 12:49.8 +14-13.

**Imatar**, 385, 9.7. March 29, 14:16.8 —29-05. April 8, 14:08.2 —29-40; 18, 13:58.1 —29-53; 28, 13:47.6 —29-44. May 8, 13:38.0 —29-17; 18, 13:30.5 —28-40.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1952.0) for 0<sup>h</sup> Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

## OCCULTATION PREDICTIONS

March 26-27 **Mercury** +1.4, 1:10.3 +11-03, 1, Im: **G** 23:15.3 ... 135; **I** 23:00.3 ... 127. Em: **G** 23:33.7 ... 166; **I** 23:27.0 ... 171.

March 31-April 1 **136 Tauri** 4.5, 5:50.3 +27-36.2, 6, Im: **A** 4:25.7 —0.9 +0.3 38; **B** 4:26.6 ... 27; **C** 4:23.4 —0.5 —0.4 58; **D** 4:20.3 —0.7 —0.3 49; **E** 4:15.3 —0.6 —1.0 78; **F** 4:23.8 —0.3 —1.6 111; **G** 3:41.7 —1.3 —1.0 80; **H** 4:00.7 —0.8 —2.7 132; **I** 3:31.2 —1.4 —1.1 93.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion, standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

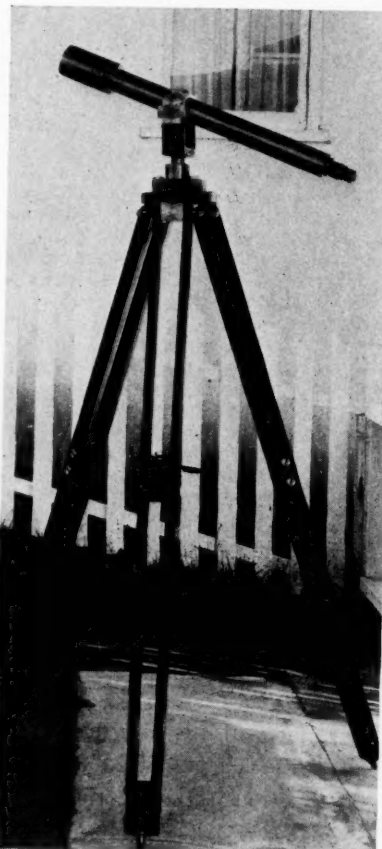
Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	E +91°.0, +40°.0
B +73°.6, +45°.6	F +98°.0, +31°.0
C +77°.1, +38°.9	G +114°.0, +50°.9
D +79°.4, +43°.7	H +120°.0, +36°.0
I +123°.1, +49°.5	

## A CONVENIENT TELESCOPE

**R**EPRESENTING the opposite extreme to an equatorial assembly provided with circles and clockwork is the telescope shown in the accompanying picture. The idea was inspired by the series of articles by David W. Rosebrugh, where in October, 1950, page 310, he mentions that his small refractor is out more frequently than the larger refractor and the reflector.

Essentially, this combination of mounting and 2¼-inch refractor is intended for



The refractor can be easily set up on its sturdy tripod.

those, including the writer, who are adverse to bestowing much time and effort to setting up an instrument for random gazing. Only two trips are required: the first to get the tripod and set it up, the second to go back into the house and get the telescope, which has trunnions attached to it, and merely set it in the fork.

The bearings of the fork are relieved. They are two inches in diameter, but only about ½ inch of each half circumference is used. The tube is of aluminum, and all other metal parts were made from scraps of brass, bronze, stainless steel, and bus-bar copper. The mounting is extremely rigid and very smooth-working, without being too loose. The maximum angle of elevation is about 70 degrees, about the limit without the use of a diagonal.

O. M. ERPENSTEIN  
1395 Hillcrest Blvd.  
Millbrae, Calif.

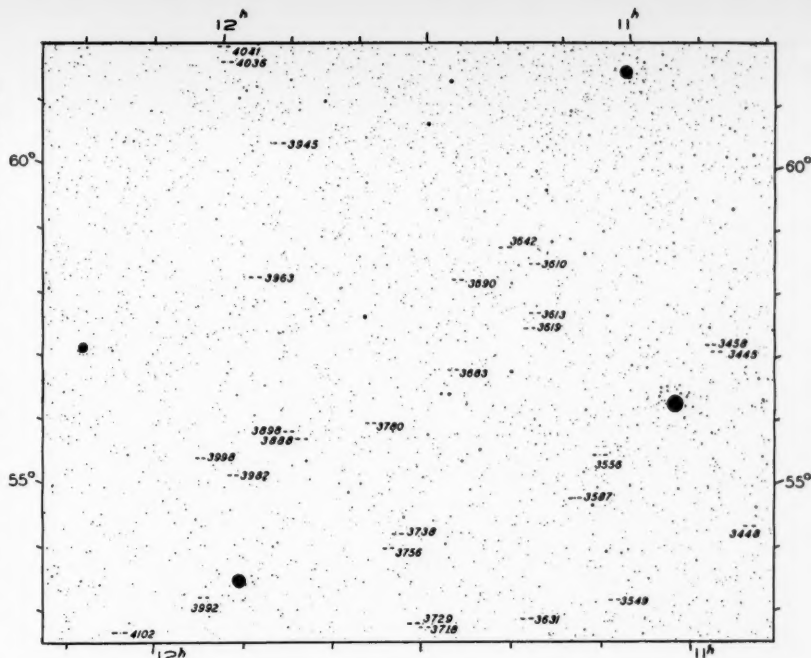
## DEEP-SKY WONDERS

THE GREAT cloud of galaxies that dominates the Virgo-Coma region extends far northward to the end of Ursa Major. Even the empty-looking bowl of the Dipper contains enough bright galaxies to surprise the amateur and furnish him activity for more than one evening.

The back cover this month is a Harvard Observatory photograph of the Big Dipper bowl, reaching a magnitude of about 12.5. On the accompanying chart are marked positions of the galaxies in this region listed in the Shapley-Ames catalogue. This chart is a reduced negative of the back-cover picture. Some of the galaxies are so small and faint as to be invisible on this scale, but their positions with reference to brighter stars and the information in the accompanying list may enable the observer to find them.

The types are: spiral, Sa, Sb, and Sc; barred spiral, SBa, SBb, and SBc; elliptical, E and Ep (peculiar); irregular, I. The colon refers to uncertain data. The Owl nebula is about 150 seconds of arc in diameter.

WALTER SCOTT HOUSTON



NGC	Herschel Mag.	Dimensions	Type	R. A. h m	Dec. °
3445	267 <sup>1</sup>	12.9	1.2 x 1.2	Sc	10 51.6 +57 15
3448	233 <sup>1</sup>	12.6	1.8 x 0.3	Sc	10 51.7 54 34
3458	268 <sup>1</sup>	13.0	...	...	10 53.0 57 22
3549	220 <sup>1</sup>	12.8	2.7 x 0.8	Sc	11 08.2 53 39
3556	46 <sup>5</sup>	11.0	8.0 x 1.5	Sb	11 08.7 55 57
3610	270 <sup>1</sup>	11.7	1.4 x 0.8	E	11 15.6 59 04
3613	271 <sup>1</sup>	12.0	1.8 x 0.7	E	11 15.7 58 17
3619	244 <sup>1</sup>	12.8	1.0 x 1.0	Sa	11 16.5 58 02
3631	226 <sup>1</sup>	11.8	4.6 x 4.6	Sc	11 18.3 53 28
3642	245 <sup>1</sup>	12.4	5.3 ...	Sc	11 19.6 59 21
3683	246 <sup>1</sup>	13.2	...	...	11 24.8 57 09
3690	247 <sup>1</sup>	12.1	1.4 x 0.4	S:	11 26.0 58 49
3718	221 <sup>1</sup>	12.4	3.0 ...	SBb	11 29.9 53 21
3729	222 <sup>1</sup>	13.0	...	...	11 31.0 +53 24

NGC	Herschel Mag.	Dimensions	Type	R. A. h m	Dec. °
3738	783 <sup>2</sup>	12.2	1.1 x 0.7	I	11 33.1 +54 48
3756	784 <sup>2</sup>	12.5	3.5 x 1.4	Sc	11 34.1 54 34
3780	227 <sup>1</sup>	12.6	2.5 x 2.0	Sc	11 36.7 56 33
3888	785 <sup>2</sup>	13.0	...	...	11 45.0 56 15
3898	228 <sup>1</sup>	12.0	2.7 x 0.7	Sa	11 46.7 56 22
3945	251 <sup>1</sup>	12.1	1.6 ...	SBa	11 50.6 60 57
3963	674	12.7	1.9 x 1.9	S	11 52.4 58 46
3982	624	11.8	2.3 ...	Sc	11 53.9 55 24
3992	614	11.2	7.0 ...	SBc	11 55.0 53 39
3998	229 <sup>1</sup>	11.6	1.7 x 1.3	Ep	11 55.3 55 44
4036	253 <sup>1</sup>	11.9	4.0 x 1.0	Sa	11 58.9 62 10
4041	252 <sup>1</sup>	12.0	2.0 x 2.0	Sc	11 59.7 62 25
4102	225 <sup>1</sup>	12.1	2.3 ...	SBb	12 03.8 52 59
3587	M97	11	Owl Planetary	11 11.9	+55 17

## Planetarium Notes

**BALTIMORE:** *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

**SCHEDULE:** 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

**BOSTON:** *Little Planetarium.* Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.

**SCHEDULE:** Tuesday through Friday, 3 and 4 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. In charge, John Patterson.

**BUFFALO:** *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

**SCHEDULE:** Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

**CHAPEL HILL:** *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

**SCHEDULE:** Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

**CHICAGO:** *Adler Planetarium.* 900 E. Ach-

sah Bond Drive, Chicago 5, Ill., Wabash 1428.

**SCHEDULE:** Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

**KANSAS CITY:** *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

**SCHEDULE:** Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

**LOS ANGELES:** *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

**SCHEDULE:** Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

**NEW YORK CITY:** *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

**SCHEDULE:** Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

**PHILADELPHIA:** *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

**SCHEDULE:** Tuesdays through Sundays, 3

p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

**PITTSBURGH:** *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

**SCHEDULE:** Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

**PORTLAND, ORE.: Oregon Museum of Science and Industry Planetarium. 908 N.E. Hassalo St., Portland 12, Ore., East 3807.**

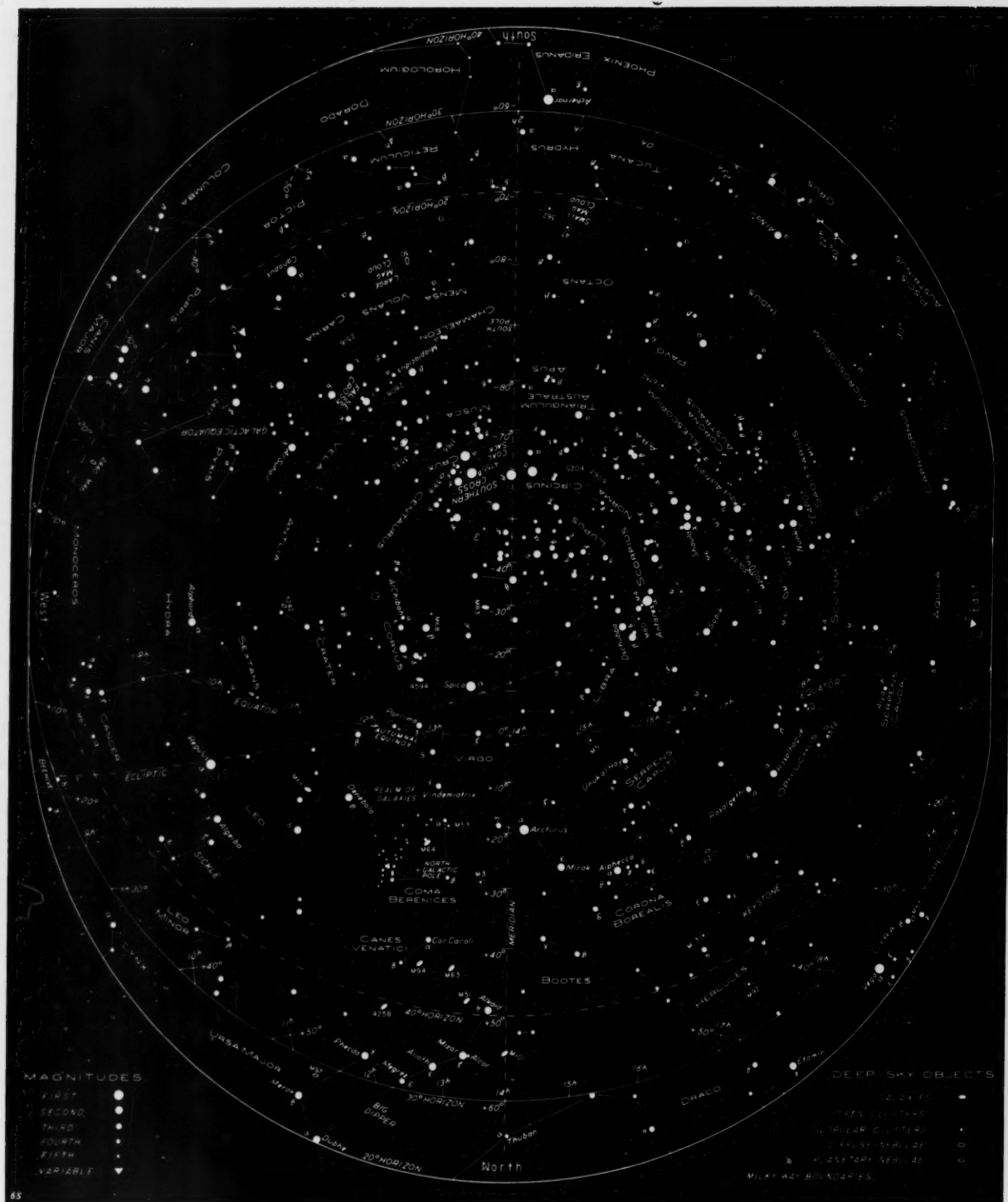
**SCHEDULE:** Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

**SPRINGFIELD, MASS.: Seymour Planetarium. Museum of Natural History, Springfield 5, Mass.**

**SCHEDULE:** Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

**STAMFORD:** *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

**SCHEDULE:** Sunday, 4:00 p.m. Special showings on request. Admission free. Spitz projector. Director, Ernest T. Luhde.



The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of June, respectively.

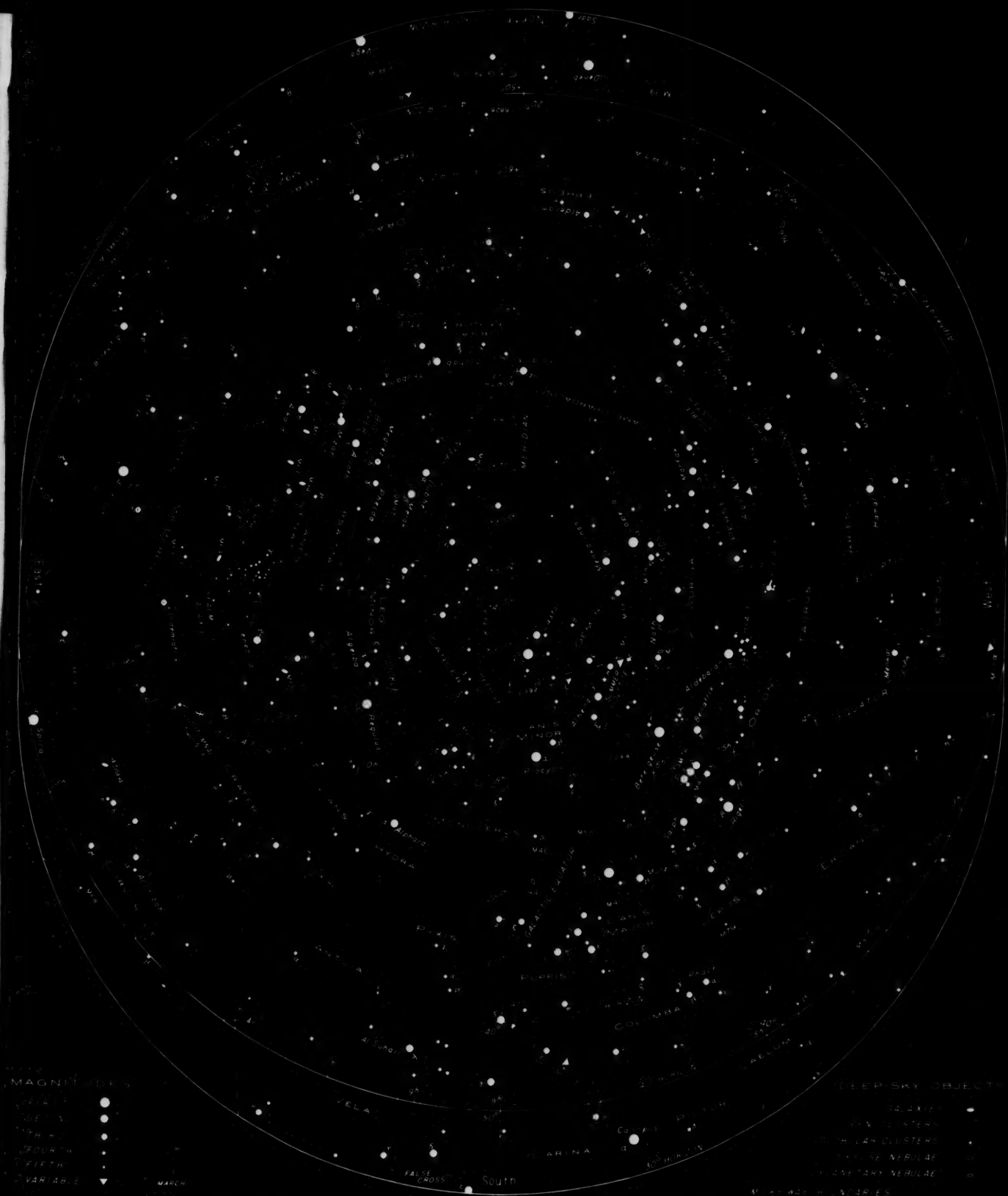
### SOUTHERN STARS

**T**HE *Celestial Globe of Jodocus Hondius of 1600*, is the title of the late Father John W. Stein's article mentioned last month, in the *Miscellanea Astronomica* of the Vatican Observatory, III, No. 101, 1950, which shows three photographs of the globe. According to Father Stein, the first globe by Hondius was dated 1592.

"Of his next globe, built in 1600, only two certainly identified specimens remain: one is in the Nautical Museum of Amsterdam and the other is in the collection of the Henry E. Huntington Library in Pasadena, California."

It is to these, then, that one must look to see the 12 constellations formed by Pieter Dirksz Keijser during his stay at Madagascar in 1595-1596. This honor has been misappropriated by Frederick de

Houtman, who in 1603 published a catalogue giving the positions and magnitudes of 303 stars, of which 107 are found in Ptolemy. But serious doubt has been thrown on his having been in a situation to make the observations himself. Houtman was a member of the ship's company on Keijser's voyage to the Southern Hemisphere, and appears to have taken advantage of Keijser's death to receive credit for his work.



## STARS FOR MARCH

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time,

on the 7th and 23rd of March, respectively; also, at 7 p.m. and 6 p.m. on April 7th and 23rd. For other times, add or subtract  $\frac{1}{2}$  hour per week. When

facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.



